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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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The British Cast Iron Research Association.

At its Annual General Meeting on June 10 in Birmingham, the Institute of British Foundrymen passed a resolution relating to the British Cast Iron Research Association. The resolution was carried unanimously, and the spontaneous support which was forthcoming from a number of eminent members of the Institute, speaking in its favour, showed in what high esteem the work of the Association is held by the industry. The terms of the resolution are as follow:—

> "The Institute of British Foundrymen, assembled in General Meeting, draws the attention of all founders to the value, both economic and technical, to the industry, of the work of the British Cast Iron Research Association. In view of the immediate necessity for the Association to double its present income from the industry in order to qualify for the same Government grant, the Institute strongly recommends and urges all foundry proprietors to support it as ordinary members."

It is well known that, while there are several manufacturers' associations to which foundries in different sections of the trade belong, there is no single and all-embracing association able to provide funds for the support of a research association in the manner, for example, that the National Federation of Iron and Steel Manufacturers provides for its offshoot, the Iron and Steel Industrial Research Council.

This lack of a manufacturers' association for the industry as a whole is one which frequently reacts to the detriment of the trade and one which we have repeatedly deplored in these columns. It is well known, from American experience, that one of the most effective ways of reconciling public opinion to the existence of a strong manufacturers' association is the support by those associations of organised research. The electrical industry in this country is a case in point where the manufacturers' association has always identified itself in the fullest possible degree with research on which the industry is based. The position in which the Cast Iron Research Association is placed is not in any way due to shortcomings on its own part. It has shown during the last seven years a steady increase in the support it gets and in its value to the industry.

The Association was begun in 1921 with the aid of a Government grant, with the intention that after five years it should assume complete responsibility for its financial support. Through various causes, and as a consequence of the advocacy of its officers, the Government has been persuaded to continue support on the original basis until July 1 of this year (that is, this week). Two years ago the Council were able to achieve the further concession of continued Government support on a basis not less than hitherto, that is, on the basis of a Government grant of £5,000 per annum, but, in return, the Government requested that the industry should double the support which it has hitherto provided. It is unlikely that any difficulty would have been experienced in achieving this result but for the deplorable setback which trade has received during the past few months, and which could not have been foreseen by anyone. No one could have conceived the state of affairs which would make the comparatively lean years since 1922 seem like times of prosperity. It is admitted that the causes are very largely political, and within the last few days events have begun to move in a direction which might bring about a restoration of more normal conditions. There is, however, a real danger that the state of the times may adversely affect the attempt which the Association is compelled to make as a condition of its future existence.

So confident are we of the possibilities of research applied to the industry within the next 10 years (and the successful culmination of this effort to raise further income will ensure the Association's future for at least 10 years to come) that we have decided to place at the disposal of the Association during the next three months space in which the industry may be told what the position is, what it is doing and how its activities can help the industry.

Speaking with the full weight of our editorial experience of the position of the trade, its possibilities and the developments being made abroad, we strongly recommend all people who have foundries to act in the spirit of the Institute of British Foundrymen's resolution, referred to above. We know that the Association enjoys much goodwill among those connected with foundries who do not get support, and we think that much useful help could be rendered if those who are engaged in the technical and manufacturing posts in the industry would bring this matter to the attention of their principals.

Physical Constants.

In dealing with the many technical problems which arise in all branches of industry at the present time, one is handicapped by the lack of accurate and reliable physical data which is necessary if satisfactory solutions are to be obtained. It is true that during the last thirty years, and particularly during the last ten years, much has been done by the physicist to remedy this state of affairs. The introduction of physical chemistry and its more intensive application to the study of technical questions, the invention and perfection of more accurate measuring instruments, and the various applications of X-rays have been the means by which progress has been made possible. We would instance the development which has taken place in the thermal study of metals and alloys as a typical case. This has been accomplished by applying the principles of physical chemistry to metals and by the use of the microscope and other instruments.

There still remains, however, a vast field to investigate, particularly in relation to the determination of physical constants. The engineer, in considering problems connected with all types of engines and more especially with the internal-combustion engine, finds it necessary to know the specific heats of the materials which he is using when dealing with questions relating to static conditions of temperature, and the thermal conductivities of the materials when the problems relate to varying temperature conditions. The steel-maker and foundryman encounters many problems connected with the casting of materials, and in order to elucidate the physical changes

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taking place finds an accurate knowledge of such properties as density, thermal expansion, specific heat and thermal conductivity essential. In research work and other investigations the same requirements apply, whether the work is of a chemical or metallurgical nature. It may be pointed out that values and coefficients for many such properties are to be found in text-books and tables of references, and, while agreeing that such is the case, we feel that a large proportion of such data is useless owing to the vague and unsatisfactory manner in which it is stated. Coefficients are given for a particular property, such as thermal conductivity, for steel, cast iron, brass, etc., with few particulars as to the composition or condition of the material to which they refer, and while such values for this or other properties may have been useful in the past, modern developments in metallurgical and engineering practice demand a greater degree of accuracy.

We welcome, therefore, systematic investigations on physical properties such as have recently been carried out, and would point out that where this work has been done considerable variation sometimes exists in a particular property of an alloy, due to comparatively slight differences in composition and to changes in structure brought about by various treatments, thermal or otherwise. This is very noticeable in the case of cast iron, owing to its complex nature, and is well illustrated by considering the thermal and electrical conducting properties of this material, which are reviewed in an article in this issue. The relationship between the thermal and electrical conductivity whereby the product of the thermal conductivity and electrical resistivity is equal to a constant has been found to be fairly accurate for most pure metals and for a considerable number of alloys, including steel and brass. With cast iron, however, there is a fair variation between white and grey irons and with irons of both types, when subjected to treatments which produce graphitisation, due to the different conducting powers of graphite, cementite and ferrite. For similar reasons variations in the total-carbon and silicon contents produce marked changes in the conducting properties of cast iron, and changes also follow small additions of special elements. What happens in the case of these two properties happens also with other properties, and indicates the extreme care—not invariably shown—which must be taken in carrying out such determinations and tabulating the results obtained if the work is to be of practical value to those who require and are depending on such data.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Cast-Iron Columns *v.* Steel Stanchions.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In view of your efforts for the better appreciation of castings, the following statement is just one more example:—

One particular proof of the superiority of cast iron over rolled steel for vertical supports is very often overlooked by designers, architects and founders themselves; indeed, the majority of the two former classes never give the matter a thought. Where there is dampness arising from the floor, as in a moulding shop, or where the floor is wet or subject to continued washing, as in a brewery or dairy, it will be noticed that in time the edges of the stanchions are "pitted" or eaten away at, and just above, the floor level. Not so with cast iron. No amount of painting will stop the "rot" in steel, under these circumstances.—Yours, etc.,

"PHŒNIX."

Institute of British Foundrymen.

THE JUNIOR VICE-PRESIDENT.

Mr. C. E. Williams, the recently-elected Junior Vice-President of the Institute of British Foundrymen, was born in 1866, his father, the late Mr. Lewis Williams, J.P., being chairman of the Cardiff School Board during the entire existence of School Boards. Mr. Williams was educated at the Manor House School, Clapham, The Leys School, Cambridge, and the South Wales University College, which he entered in 1883 as its first student. He joined the firm of John Williams & Sons in 1884, and became manager of the Globe Foundry & Engineering Works, Cardiff, in 1887. The Globe Foundry was incorporated with John Williams & Sons (Cardiff), Limited, when that company was formed in 1899.

Mr. Williams is chairman of the board of directors of John Williams & Sons (Cardiff),

MR. C. E. WILLIAMS

(Junior Vice-President of the Institute of British Foundrymen).

Limited; Williams (Barry), Limited; Emery Bros., Limited, Birmingham, and also a director of the Principality Building Society, Cardiff. He has been the President of the Cardiff and District Master Ironfounders' Association for about 33 years, and his services were recognised by the presentation of his portrait in oils on the occasion of a complimentary dinner. A second local activity is that he occupies the position of treasurer of the Cardiff Blind Institute.

"THE CHAMBER OF COMMERCE JOURNAL" this month contains an article on "Cables and Wireless," compiled by Philip Gee, which describes recent improvements in the transmission of oversea telegrams. In 1866 the highest number of words per minute that could be transmitted was 17; to-day, in ordinary practice, from 42 to 60 words per minute are transmitted from London by one cable, while in the event of great urgency, using both cable and wireless, 540 words per minute can be transmitted from London to Australia. Mr. Gee deals also with beam-wireless transmission, the importance of the regenerator in providing speedier and more efficient service, and the effects of the amalgamation in 1929 of the beam-wireless stations, the privately-owned Eastern and associated systems, the State-owned trans-Pacific and trans-Atlantic cables and the Marconi radio system into the one undertaking of Cables & Wireless, Limited.

Random Shots.

From a London cinema poster:—

NOW ON THE SCREEN.

THE GREAT SMASHING DRAMA "CAST IRON."

Bribery and corruption on the part of forgers and welders?

* * *

Much banter has been heaped upon a well-known Midland auctioneer owing to a statement he made in putting up a bronze helmet for sale. The lot was described as an antique Roman helmet. "There was but little doubt that it originally belonged to Romulus, the Roman founder," said he, and added quite innocently, "I do not know whether Romulus was an iron founder or a brass founder."

* * *

Chestnut trees excluded, now where do you think I found that little story? In the most unlikely of places I assure you—a market report, penned and printed in the happy and (relatively) prosperous days of 1904. (To spare an editor's blushes for his predecessors, the name of the journal—a well-known one—in which it appeared I won't disclose.) Nowadays, "human-interest" stories in trade notes are about as common as opera hats on the peak of Mount Everest. And if, in this year of (dis)grace, they were allowed to appear, probably a tragic note would be theirs. As, perhaps, in this: "Few members attended the Exchange on Tuesday. There will be one less next week At the close of the meeting (business there was none) Mr. Brown drove to his stock-yard and was seen to tie two pigs of iron about his waist and run like a mad dog into the canal. The iron sank. I am able to report, therefore, that stocks have diminished slightly, but there seems little likelihood of this continuing."

* * *

An amusing situation has arisen in Edale, a little hamlet in the Derbyshire Peak country. Although the men of Edale wantEd ale they objected to paying the high price demanded for it, and as a protest decided to become teetotallers. This much I learnt from a brief note in a morning newspaper; but whether desire has yet conquered resolution or *vice versa* I am left in ignorance. Why, if Mr. G. K. Chesterton (to whom beer symbolises a not-unworthy trait of English character) were a newspaper proprietor, he would have sent his most special correspondent to Edale and next morning launched a crusade for cheaper beer. At least, that is what I personally would expect of the author of "The Flying Inn." But (more's the pity) Mr. Chesterton is not a newspaper proprietor and Fleet Street continues to urge us to drink more milk.

* * * *

IMAGINARY INTIMATE INTERVIEWS.

IX.—The Foundry Foreman.

Some people imagine that mine is a position of great responsibility. Well, it isn't. If I should happen to be late in arriving at the works in the morning my men always busy themselves upon whatever work they can. They are so hard at work when I do arrive that I can walk through the foundry two or three times before they even notice me. Slackness and untidiness do not exist in my foundry, neither does inefficiency. I never have to tell a moulder where to place a riser or gently reprove a cupola charge-hand for trying to fill the spark arrester with coke. Sometimes I leave early in the evening, but I can go with the knowledge that my men will work all the harder in my absence, proud of the fact that their foreman has implicit trust in them. The management, too, is always willing and anxious to help me by providing the latest equipment. Sometimes I sit all day and wonder whether it is necessary to die to be in heaven. I do, really!

MARKSMAN.

General Meeting of the German Foundrymen's Technical Association.

The German Foundrymen's Technical Association held its 21st general meeting at the headquarters of the German Engineers' Association, Berlin. The meeting was attended by upwards of 300 members and a large number of representatives of State and municipal authorities, polytechnics, mining colleges, many technical and economic associations and societies, as well as representatives of the daily and the technical Press. The meeting opened with an address by the chairman, Dr. C. Humperdinck, ironworks director, of Wetzlar, of which we give the following summary:

Chairman's Address.

In keeping with the gravity of the present situation (he said) it was thought fitting to hold this year's general meeting on modest lines, for, in view of Germany's impoverishment—which was much greater than it appeared to be from the official economic reports and finance statistics—it would be presumptious to make merry. Accordingly, to-day's meeting was to be regarded as a day of work, in which, indeed, a certain *joie de vivre* should find an outlet, for without any joy in life and in one's work the work itself would suffer.

Speaking generally, it might well be stated that the past year had been a difficult and anxious one. Even last autumn many people were of the opinion that things could not become worse, and yet about the turn of the year a further deterioration of the economic position had been experienced. A glance at the Bourse reports would suffice to show approximately the depreciation in industrial undertakings as compared with previous years, and particularly as compared with pre-war times, on the basis of actual figures. It was especially to be regretted that since 1927, as shown by the last quarterly report of the German Foundryowners' Federation, 25 per cent. of the iron foundries belonging to the Federation had closed down. In other branches of the iron industry the outlook was no better.

On closer observation it would be seen how difficult also were the prospects of finding positions for the younger generation. For their college graduates the outlook was particularly gloomy, and here it was their duty to take energetic measures.

If an improvement in economic conditions could be effected by speechmaking or by writing, then they should be comparatively well off, for in no other country had so much been spoken and written concerning the economic situation and the distressful position of industry as in Germany. The fact had not yet become generally recognised that only by action based on economic principles, and not by speechmaking, could practical progress be achieved. Equally unappreciated was the fact that without a substantial fall in production costs all along the line, the crisis could not be overcome.

Many people had already lost their self-reliance as the result of State benefits, but things must not be allowed to reach such a pitch as to cause the German foundrymen to lose even a part of their self-reliance. On the contrary, they must regard it as the supreme and bounden duty in their sphere of action to continue working indefatigably and purposefully, and equipped with the necessary wisdom and the necessary knowledge, at the task of developing their works in such a manner as to enable them to work increasingly cheaply while, at the same time, improving the quality of their products.

Industrial conditions in Germany, particularly in the post-war period, had essentially altered as compared with the pre-war period. They had to reckon with foreign competition on the world's markets—competition which had newly arisen in many countries during and after the war and which, being financially powerful, was not to be under-rated. To enable them to work successfully and gradually to extend their activities at least within the limits left to them, they must work longer and more cheaply and turn out exceptional products from the standpoint of quality, otherwise a further descent of the slippery slope was inevitable.

Dr. Humperdinck went on to point out that his remarks were animated by anxiety as to the future, and were made in the expectation that each individual member would recognise the decisive factor of personal service, and turn that factor to proper account. He most ardently desired that each of them should draw new ideas from the "great realm of realisable fancy," put these into practice and endeavour to turn them to good account from an economic standpoint. Whoever sought diligently within the limits of the possible in the manner described might rely on the probability of success. He hoped that his remarks in this respect would not fall wide of the mark, but would go unerringly home.

Papers Presented at the Meeting.

On the conclusion of the business part of the programme, which followed the chairman's address, several Papers were read, abstracts of which are given below.

Slag Formation in the Cupola Furnace, with Special Reference to Fluorspar.

By PROF. H. UHLITZSCH, Freiberg, Saxony.

The investigation into the conditions affecting the formation of cupola-furnace slag, particularly when fluorspar is used, was the outcome of deleterious effects in Saxony and of inquiries from foundries as to whether the use of fluorspar was advisable. Two research theses were thereupon begun at the Freiberg Iron-Metallurgical Institute: one theoretical, dealing with the available literature on the subject, the other practical, to substantiate the results theoretically deduced. The object was to discover a common equation or basis of comparison, and to establish the possibility of judging the melting process from the slag under totally different basic conditions. Such an equation was found in degree of acidity, that is, the relationship of acid to base radicals, as formulated in Doelter's "Handbuch der Mineralchemie" ("Manual of Metallurgical Chemistry"), and was selected for a mathematical treatment of the problem. The formulæ evolved were graphically recorded, and on the bases of these, supplemented by the results of researches already published, the probable process of slag formation with different additions was examined.

The application of the results of practical experiments confirmed the theoretical assumptions. This enabled the effects of different qualities of the additions to be considered as a whole, with the aid of comprehensive diagrammatic drawings.

Finally, analytical proof was furnished of the assumption that the fluorspar was gasified in the form of SiF_4. The deleterious action of this gas and of its decomposition products on certain concentrations is well known. In cupola-furnace working the injurious amounts can be reached under unfavourable conditions, due mainly to weather and locality. The formation of volatile sulphur fluorine compounds in the cupola furnace is inconceivable.

As a result of the facts established and with the application of further experimental material it will probably be possible to throw light also on such problems as the most favourable coke charge, desulphurisation, and quality of furnace lining.

Principles of Alloying Cast Iron with Various Metals.

By DR. F. ROLL, Leipzig.

The addition of various metals to grey cast iron has lately formed the subject of several published articles. The present Paper deals with the relations between economy and quality improvement. After defining the term cast iron, the degree of affinity between the different alloys and their influence upon the carbide in the iron were discussed. The effect upon the eutectic C and the eutectoid point S of the iron-carbon system was then dealt with, the subject being clarified by the use of diagrams.

After reference to the general metallurgical standpoints, the writer dealt with the action of the alloys upon the iron texture and graphitic structure. The physical properties of the iron and how these are influenced by additions required to be dealt with in more detail. After mentioning its behaviour in relation to corrosion and stability of volume, as also several technological properties, *e.g.*, shrinkage, the Paper concluded with a reference to the most essential data in regard to alloys obtained in practice.

Transverse Strength, Deflection and Graphite Separation.

By DR. F. BRINCKMANN, Sprottau.

In view of the importance attached to high transverse strength by users of cast iron, the writer had for several years made a practice of making a stress-strain diagram for increasing pressure at every test. To obviate the heavy variations, the deflection was uniformly measured at a pressure = 30 kg./sq. mm., a value which could be regarded as specific deflection. It would be seen from the foregoing that, as compared with the figures suggested by Thum and those of Meyersberg, the value in question had the advantage of much lower variation and of giving the designer a clearer idea as to the behaviour of the material below the limit of fracture.

Experiments with the object of relating the specific deflections to strength values gave, with satisfactory accuracy, simple curves which promise to throw fresh light on the matter after further work in this direction.

Labour and Economic Life.

By PROF. KARL DUNKMANN, Berlin.

The problem of labour in economic life to-day, according to Prof. Dunkmann, consists in the fact that while, on the one hand, the most intimate connection exists between the two—no economic life without labour—on the other hand, there is an unbridgeable gulf between them. Here labour's destiny and its paradoxical nature are revealed. The product of industry—a product of the head and of the hand—once it has left the hand of the producer pursues its own course. For it is subjected to a process of a totally different nature, namely, the process of exchange, which is comparable to an enormous centrifugal machine scattering the products far and wide to all the markets of the world, where these products meet an unforeseeable and diversified fate. It is here that prices are determined upon which the wages of labour retroactively depend. Thus labour is practically helpless as regards the fate of its own products.

The remainder of the Paper consisted mainly of the Professor's arguments against Karl Marx's theory of "labour value" pure and simple, which he showed to be untenable, especially in the exchange of goods. Here no reorganisation of the capitalistic system of economy would avail. There was only one method of helping labour to obtain its "rights," viz., a State social policy voluntarily supported by industry, but keeping within the limits of economic possibilities.

Lectures.

In connection with the general meeting, a series of lectures on foundry work, organised by the External Institute of the Berlin Polytechnic

(*Concluded on page* 4.)

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Foundry Selling Practice.

By Eric N. Simons.

(*Continued from page* 360, *vol.* 44.)

No. 5. PRESENTING MARKET DATA.

It is of little use making a comprehensive survey of a market unless the survey, when completed, is presented in a form both comprehensible and concise. A market report in the form of a mass of separate letters, odd notes on scraps of paper, a few tables, and a blueprint or two, is worth nothing. Having obtained data, they must be presented and retained in such a way that they can be examined quickly and their main implications grasped in the minimum of time.

The market report should be divided into the following sections: (*a*) General summary, giving the recommendations and conclusions; (*b*) section describing the total extent of the market; (*c*) section indicating the needs of the market, based on the statements of consumers, merchants, representatives, on statistical data, etc.; (*d*) section detailing the type and amount of competition, with prices and characteristics of the competing products; (*e*) section setting out the problem of selling in the market as it affects publicity, distribution and sales; (*f*) section describing any modifications to or alterations of the castings to fit them for the market; (*g*) section, where necessary, showing alternative cost figures for existing production methods, and methods modified to suit new or improved products. The report should be as brief as is consistent with clarity and thoroughness. Each section should be clipped separately, so that it can be read apart from the rest if desired. The general manner of presentation should be impersonal. The writer should avoid such remarks as "it is obvious from these facts that," and similar personal interpretations. It is for those who have ordered that the report should be prepared to consider what is obvious and what is not, what action should be taken and what should not. Any conclusions or recommendations of a personal character should be confined to the section of inferences and recommendations.

A report should not look like a Chinese puzzle, nor should it be like a child's A B C. In other words, while a few charts and tables may, if well drawn up, be helpful, excessive intricacy or a plethora of them makes the report look far too formidable to be welcomed by the management. Similarly, while the more intricate inferences and data may be explained by footnote or sentence, unnecessary explanations become irritating to the business man who knows his job. Padding and irrelevancy should be eliminated.

On the other hand, anything that will facilitate reference to, reading and handling of, the report should be adopted. It is a good plan to have the sheets bound in a loose-leaf folder or binder, so that any later reports or accounts of action taken can be bound with them. This also makes the report more durable.

Charts and Graphs.

Charts, graphs, maps, tables, photographs, are all valuable in making a report clearer and more quickly comprehensible, and where they can be safely introduced, it is advisable to use them. Charts are often easier to understand than masses of figures. They need not be elaborate. In fact, any chart that a person of ordinary intelligence cannot grasp in a few minutes is a bad chart, and should not be included. Not many people can readily grasp and visualise the significance of figures presented as such. A table to not a few business men conveys little or nothing. But a similar series of data expressed in chart form often makes an enormous difference to their understanding of the facts required to be conveyed. An important point is that the scope and title of any chart employed should be clearly stated underneath it, quite apart from any textual explanation.

Graphs are excellent means of indicating comparisons over a given period of time, and they also serve admirably to demonstrate and contrast tendencies in a particular direction. For example, the same page can be used to reveal both the increase in a foundry's annual turnover and the corresponding increase in the general production of the industry as a whole. A comparison thus expressed is far more striking than would be two sets of tables of figures. Graphs can also be employed to show price fluctuations and changes. There are numerous types of graphical charts, all of which can be used effectively, but it would be entering into too great detail to describe these here.

Maps are very useful in market surveys, especially where it is desired to show where sales are best, most probable, worst, least probable, and so forth. They can also show the character and extent of competition, the location of merchants and industries, the districts of representatives, the intensity of industrialisation and similar groups of data. The different areas can be given distinguishing colours or shaded in various ways; circles and dots can be used to demonstrate particular activities. Distinctive symbols can indicate special industries or markets.

Writing the Summary of the Report.

By far the most important part of the report is the summary. In half an hour, if this is properly done, the reader with little time to spare should be able to get the gist of the whole survey. The true test of a sales manager or market investigator is his ability to get the pith and marrow of months of research work and study into a few concisely written pages. Every sentence should be short and to the point. Every new subject should have its own paragraph. Every paragraph should be in logical sequence with its predecessor and successor. The conclusions must be absolutely faithful to the facts and capable of verification by reference to the detailed survey. In some instances, firms which have commissioned market reports have refused to allow the investigator and writer of the general report to prepare the summary, but have entrusted this work to an independent person, so that the survey may be summarised by someone with a fresh, impartial and open mind. This has its advantages, especially as it ensures a measure of criticism of the survey, sometimes revealing flaws in the reasoning or imperfections in the method of survey adopted.

Conclusions based on the facts should constitute the first part of the summary. But while it is not the investigator's work to carry out the policy that the survey shows to be desirable, it is advisable that he should include in the report an outline of the action he thinks should be taken. Action based on the conclusions reached is essential if the report is to be fully used, and recommendations should be made, if only to serve as a basis for any board or managerial discussions.

For example, a report may indicate that a new design of casting is needed, and greatly needed, if the market is to be captured. A recommendation would take into consideration that the company's financial position did not allow of its putting down a lot of new plant to make this new type of casting, and might suggest, as a compromise, the purchase of second-hand plant, or the buying up of some other concern, or the factoring of the type of casting required until such time as it could be made on the premises.

No investigation will unearth every fact about the market nor answer every question. It will be as well to set down on paper every unanswered query that arises, and every group of facts that should at some future date be assembled. Market reports, having been secured, should not—and this is most important—be regarded as final, and dead when acted upon. A market report or survey is, and should be, regarded as a living thing, to be modified and added to and kept alive by all sorts of later supplementary investigation. Of this type of work which is called, broadly, sales promotion work, more will be written in a later section.

Now, having indicated the preliminary details of selling practice, more serious and vital aspects may be examined. First amongst these comes the product. What influence has, or should have, the sales department upon the product? In what way should the product be regarded from the selling point of view? What is the product as it affects sales? What problems of selling does it create, and how are these to be handled? These questions and many others the author hopes to answer in the immediately succeeding sections.

(*To be continued.*)

General Meeting of the German Foundrymen's Technical Association.

(*Concluded from page* 3.)

in co-operation with the German Foundrymen's Technical Association, the German Metallurgical Society and the Federation of German Metal Foundries, was given at the Charlottenburg Polytechnic.

In addition, Polytechnic lectures on the use of X-rays in foundry work were given, with practical demonstrations, by the Metallurgical Institute of the Polytechnic, in conjunction with the German Foundrymen's Technical Association, and Committee 60 of the German Association for the Testing of Industrial Materials.

Before the general meeting began, the Pattern-making Exhibition, organised for instructional purposes by the German Foundrymen's Technical Association and the German Association for Testing Materials, was opened at the headquarters of the German Engineers' Association.

Alloys of Iron Research.

In 1929 the "Alloys of Iron Research" was organised by The (American) Engineering Foundation, with the assistance of an advisory committee appointed by the American Institute of Mining and Metallurgical Engineers. With co-operation of the American Iron and Steel Institute, several technical societies, research institutes and government bureaux, and a number of leading executives in the iron and steel industry, £46,000 was subscribed to finance the work for a period of five years. The Iron Alloys Committee was appointed to assume active charge.

The purpose of the "Alloys of Iron Research" is threefold:—(1) To review critically all research work on iron and its alloys, as reported in the technical literature of the world from 1890 to date, and to assemble the data thus collected in form convenient for reference. (2) To publish information collected by this critical review in two kinds of books:—(*a*) Monographs, for the scientist and research worker, and (*b*) manuals, for the technician, the executive and the engineer in the ferrous industries and related fields. (3) To call attention in these books to errors in existing data; to define clearly the gaps now present in the knowledge of the alloys of iron, both of pure alloys and of commercial irons and steels; and to encourage and promote research for basic facts to fill these gaps.

The Thermal and Electrical Conductivities of Cast Iron.

By J. W. Donaldson, D.Sc.

A considerable number of investigations has been carried out during the last twenty years on the electrical properties, and to a lesser extent on the thermal properties, of steel and of non-ferrous alloys. The number of researches dealing with similar properties in cast iron, however, has been extremely limited, and it is only within the last few years that systematic investigations have been initiated. On the thermal side the necessity for a better knowledge of the thermal properties of cast iron has been brought about by the development of the internal-combustion engine, where questions of the transference and dissipation of heat frequently arise, and by problems connected with the casting of ingots of steel and other alloys, where the ingot moulds are manufactured of cast iron. The electrical conductivity of cast iron is low, and consequently its electrical resistance is high, and this is advantageous in some cases from a practical point of view. There is also the relationship which exists between the thermal and electrical conductivities, and, from the investigations which have so far been carried out, it would appear that the thermal conductivity is exactly analogous to the electrical conductivity.

In 1904, Drude developed a theory for the electrical conductivity of metals, and this theory is dealt with in a very concise manner by Lorentz in his May lecture to the Institute of Metals in 1925. Drude's theory shows that the product of thermal conductivity and electrical resistance is equal to constant absolute temperature, and accounts for the fact that metals are at the same time either good conductors for both heat and electricity or, *vice versa*, bad conductors. It also accounts for the Wiedemann and Franz's Law, propounded in 1853, according to which $\lambda\sigma = k$, where λ = thermal conductivity, σ = electrical resistivity, and k = a constant for all pure metals. These theoretical deductions and conclusions have been shown to be fairly accurate by means of experimental research so far as pure metals are concerned. In 1900, Jaeger and Diesselhorst showed that the ratio of the two conductivities for a number of pure metals over the range from 18 to 100 deg. C. was nearly constant, and did not vary greatly between metals. Lee's investigations at 18 deg. C. and down to − 170 deg. C. confirmed those previous investigations, except that there was more variation among individual metals. Recent work by Griffiths and Schofield also showed the relationship to hold with a fair degree of accuracy.

The importance of this law, from the practical point of view, is that the thermal conductivity can be deduced from the electrical conductivity. The thermal conductivity is a very difficult property to measure experimentally, particularly at high temperatures, whereas the determination of the electrical conductivity presents very much less difficulty. If it can be established that the Wiedemann and Franz's Law applies to alloys as well as to pure metals, and that it holds as the temperature increases, then the thermal conductivity can be approximated to very readily, and very easily, with a fair degree of accuracy from the electrical determination, and it will enable the values of the thermal conductivity of cast iron to be calculated for the higher temperatures where there is an increasing demand for such data.

Thermal Conductivity.

Conductivity determinations for cast iron have largely been confined to thermal determinations, and many of these have only been made at one temperature. The earliest work is probably that of Beglinger, referred to by Jakob[1] in his review of the thermal conductivity of metals and alloys. Jakob states that this investigator examined 31 cast irons at 10 deg. C. and found their thermal conductivity to vary from 0.093 to 0.153. He gives no information as to the relative composition of the various irons or the method by which the determinations were carried out. Determinations for a cast iron by Callendar[2] give the thermal conductivity at 54 deg. C. as 0.114 and 0.111 at 102 deg. C. The composition of this iron is given as C 2.0, Si 3.0 and Mn 1.0 per cent. For an iron containing C 3.5, Si 1.4 and Mn 0.5 per cent., Hall[3] gives a conductivity value of 0.149 at 30 deg. C. In the eleventh report of the Alloys Research Committee of the Institute of Mechanical Engineers, 1921, thermal conductivity values are given for a cast iron containing Gr. C. 2.64, C.C. 0.85, Si 1.84, Mn 0.82, S 0.078 and P 1.09 per cent. In its cast condition the conductivities at 100 and 300 deg. C., respectively, were 0.102 and 0.099, and after annealing at 450 deg. C., 0.121 and 0.113 at similar temperatures.

Masumoto,[4] in his investigations on the electrical and thermal conductivities of carbon steel and cast iron, deals with a series of irons, which are mainly white iron. Sixteen irons with carbon contents ranging from 2.41 to 4.63 per cent. were tested. The silicon contents varied from 0.12 to 0.54 per cent., and the manganese in all the irons was below 0.10 per cent. These were chill-cast and only specimens showing no graphite were tested. Determinations of the thermal and electrical conductivities were first made on the cast bars, then after repeated annealing at 1,000 deg. C. for 2 hrs., 1,000 deg. C. for 4 hrs. and 1,090 deg. C. for 2 hrs. In Table I the values obtained from four of the irons, Nos. 1, 6, 10 and 16, are given, and micro-examination shows that graphitisation occurred in specimen 10 after the second annealing and in specimen 16 after the first annealing. The thermal conductivities of these 16 irons decreased from 0.0772 to 0.0335 as the silicon content increased, and the electrical resistivity or specific resistance increased from 2.59 to 7.13 over the same range, while the product $\lambda\sigma$ varied from 0.200 to 0.239, increasing slightly with increasing carbon content. The first annealing at 1,000 deg. C. gave rise to an increase in the thermal conductivity and a decrease in the electrical resistivity, but no effect was observed after repeated annealing even with increased temperature, except where annealing was accompanied by graphitisation. Where graphitisation occurred, there was a considerable increase in the thermal conductivity and a decrease in the electrical resistivity and an increase in the product. Further tests with three irons of higher silicon content gave similar results (Table I). The first two of these irons, Nos. 17 and 18, were white on casting, but showed considerable graphitisation on heat-treatment at 800 deg. C. for 1 hr.

Masumoto considers the rapid increase in the conductivity, both thermal and electrical, produced by graphitisation, to be due to the high conductivity of ferrite as compared with that of cementite or graphite, as the values of the two conductivities do not differ to any great extent either for cementite or graphite, while those for ferrite are several times greater than those for cementite and graphite. Consequently, when cementite decomposes into ferrite and graphite, due to their larger mass ratio, the conductivity increases abruptly. Three curves representing the relationship of the thermal and electrical conductivities and their ratio to carbon concentration are obtained, and by extrapolating these curves the thermal conductivity, electrical resistivity, and their product for cementite are found to be about 0.017, 14.0 and 0.24, respectively. The corresponding values for ferrite are 0.1741 and 1.044.

In 1928 the author[5] published the results of a series of investigations on thermal conductivity carried out to determine (1) the conductivity of a commercial grey cast iron, (2) the influence of special element additions on the conductivity and (3) the influence produced by heat-treatment on the conductivities of both series of irons. For the experiments, tests were made on four plain irons containing 0.65, 1.24, 1.48 and 1.91 per cent. of silicon, respectively,

TABLE I.—*Thermal and Electrical Conductivities (Masumoto).*

Cast iron.		As-Cast.	1,000 deg. C. for 2 hrs.	1,000 deg. C. for 4 hrs.	1,090 deg. C. for 2 hrs.
No. 1. C 2.41 per cent., Si 0.12 per cent.	λ	0.0772	0.0810	0.0806	0.0809
	σ	2.59	2.42	2.42	2.43
	$\lambda\sigma$	0.200	0.196	0.195	0.197
No. 6. C 3.17 per cent., Si 0.21 per cent.	λ	0.0622	0.0648	0.0649	0.0656
	σ	3.47	3.25	3.26	3.24
	$\lambda\sigma$	0.216	0.211	0.212	0.213
No. 10. C 3.96 per cent., Si 0.20 per cent.	λ	0.0470	0.0504	0.0625	0.1217
	σ	4.72	4.44	3.72	2.23
	$\lambda\sigma$	0.222	0.224	0.233	0.271
No. 16. C 4.63 per cent., Si 0.54 per cent.	λ	0.0335	0.1370	—	—
	σ	7.13	1.8	—	—
	$\lambda\sigma$	0.239	0.247	—	—
No. 17. C 3.82 per cent., Si 1.24 per cent.	λ	0.0346	0.0506	—	—
	σ	6.35	4.74	—	—
	$\lambda\sigma$	0.220	0.240	—	—
No. 18. C 3.81 per cent., Si 1.96 per cent.	λ	0.0346	0.0878	—	—
	σ	6.35	2.50	—	—
	$\lambda\sigma$	0.220	0.220	—	—
No. 19. C 3.84 per cent., Si 1.98 per cent.	λ	0.1062	0.1286	—	—
	σ	7.28	5.67	—	—
	$\lambda\sigma$	0.773	0.729	—	—

800 deg. C. for 1 hr.

λ = Thermal conductivity. σ = Electrical resistivity.

1 M. Jakob. Zeitschrift für Metallkunde, 1924, Vol. 16, p. 253.
2 H. L. Callendar. Rep. Brit. Assoc., 1897.
3 Hall. Dictionary of Applied Physic (Glazebrook), Vol. 1, p. 443.
4 H. Masumoto. Science Reports, Tohoku Imp. Univ., 1927, Vol. 16, p. 417.
5 J. W. Donaldson. Proc. Instit. of Mechan. Engineers, 1928, No. 4, p. 953.

with approximately T.C. 3.0 to 3.2, Mn 1.0, S 0.07 and P 0.7 per cent. The alloy irons tested were two manganese irons containing 1.87 and 2.43 per cent. manganese, two chromium irons containing 0.198 and 0.392 per cent. chromium, an iron containing 0.746 per cent. nickel, another containing 0.124 per cent. vanadium and a third containing 0.475 per cent. tungsten. These irons were all of similar composition to the iron containing 1.48 per cent. silicon, except the tungsten iron, which compared with the 1.91 per cent. silicon iron. The low-silicon iron was a grey iron, being cast in a hot mould by the Perlit process.

The thermal-conductivity determinations were made on each of the irons over a range of temperatures from 75 to 425 deg. C. Each iron was tested over this range in its cast condition, then the 1.48 per cent. silicon iron was tested after heat-treatment at 550 deg. C. for 40, 80, 120, 160 and 200 hrs. respectively, and, as a result of the conductivity values obtained after these various periods of treatment, all of the plain irons and some of the alloy irons were heat-treated for 200 hrs. at 550 deg. C. and tested over the 75 to 425 deg. C. range. Table II gives the summarised results of the conductivity values obtained.

Table II.—*Thermal Conductivities (Donaldson).*

Cast iron. No.	Composition, per cent.	Thermal conductivity = λ. As-Cast. 100 deg. C.	As-Cast. 400 deg. C.	After 200 hrs. at 550 deg. C. 100 deg. C.	After 200 hrs. at 550 deg. C. 400 deg. C.
S. 1	Si 0.65	0.135	0.114	0.137	0.115
S. 6	Si 1.24	0.128	0.109	0.133	0.112
S. 8	Si 1.48	0.122	0.107	0.131	0.112
S. 9	Si 1.91	0.110	0.103	0.120	0.107
M. 3	Mn 1.87	0.120	0.104	—	—
M. 4	Mn 2.43	0.118	0.101	0.123	0.103
Cr. 1	Cr 0.198	0.127	0.112	—	—
Cr. 2	Cr 0.392	0.131	0.114	0.135	0.116
N.	N 0.746	0.108	0.101	0.118	0.107
V.	V 0.124	0.122	0.103	—	—
W	W 0.475	0.118	0.105	0.122	0.108

Influence of Temperature and Special Elements.

As a result of these determinations it would appear that the thermal conductivity of grey cast iron varies from 0.110 to 0.137 and decreases as the temperature increases. The values obtained depend on the composition of the iron, the influence of silicon being to lower the heat-conducting value of the material. Nickel has a similar effect, as have also manganese and vanadium, although to a lesser degree. The elements chromium and tungsten tend to raise the conductivity. Heat-treatment at 550 deg. C. at first increases the thermal conductivity, due to the pearlite decomposing to form ferrite and graphite, but this increase is followed by a slight decrease. This decrease results from the oxidation of iron in the vicinity of the graphite flakes causing a certain amount of disintegration in the metallic parts of the material.

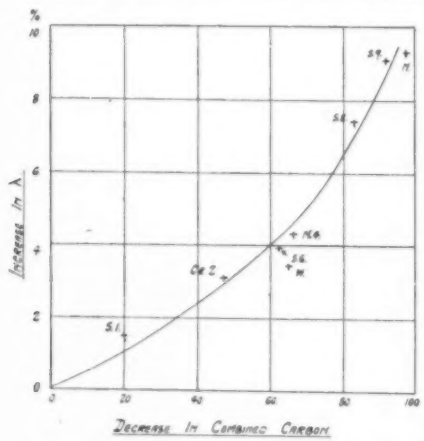

Fig. 1.—Relationship between Combined-Carbon Decomposition at 550 deg. C. and Thermal Conductivity (Donaldson).

Structure influences the thermal conductivity of grey cast iron as well as the composition, and the author is in agreement with Masumoto with regard to the relative conducting powers of ferrite and cementite. If increases in thermal conductivity, which take place in both the plain and alloy cast irons after heat-treatment, are plotted against the percentage decreases produced in the relative combined carbon by similar heat-treatment, as in Fig. 1, it is seen that a relationship exists between the increase in thermal conductivity and the decrease in combined carbon, but that it is not a linear one. It was considered that a more definite relationship might exist between the increases in the various thermal conductivities and the structural volumes of the irons, but difficulties were encountered in calculating the structural volumes of the various cast irons from their analyses. These difficulties occurred with the heat-treated irons in apportioning the combined carbon without knowing the relative rates at which it decomposes in the iron carbide, manganese carbide and iron-carbon-phosphorus eutectic of the original irons; and also in the alloy irons due to lack of data as to how chromium, nickel, vanadium and tungsten exist in cast iron.

Electrical Conductivity.

In addition to the work of Masumoto on the electrical conductivity of cast iron, there have been other investigations which have given values for this property. The most recent work is that of Partridge[6] on the magnetic and electrical properties of cast iron. This investigator determined the electrical conductivity of a series of cast irons containing from 0.6 to 7.38 per cent. silicon, and found the specific resistance or electrical resistivity to increase with increasing silicon content. Annealing at 875 deg. C. reduced the resistance in every case. It is suggested that this reduction is due to annealing causing the graphite to globularise, so that the continuity of the current is not affected to such a great extent as when the graphite is in flakes. While admitting that the condition of the graphite does affect the conducting powers of cast iron, the reduction is more probably due to the formation of ferrite from the cementite.

The influence of various elements on the electrical resistance is also investigated by Partridge. Increase of manganese from 0.63 to 2.66 per cent. increases the resistance, although not to the same extent as does a similar increase in silicon, while annealing produces little change in the resistance. An increase in resistance is also obtained with nickel additions from 0.71 to 18.83 per cent., but again the influence is not so marked as in the case of silicon additions. Aluminium additions from 0.87 to 4.09 per cent. produced a greater rise in the resistance than did similar additions of nickel, but were still considerably less than those produced by silicon. The addition of chromium up to 1.76 per cent. increased the resistance, but with 7.51 per cent. there was a large decrease, while 1.86 to 23.3 per cent. of cobalt produced a decrease of over 50 per cent. These results, so far as silicon, manganese and nickel are concerned, are in accordance with the results obtained by the author for similar elements on the thermal conductivity.

[6] J. H. Partridge. Journ. Iron and Steel Instit., 1925, Vol. 112, p. 191; Carnegie Research Memoirs, 1928, Vol. 17, p. 157.

Conclusions.

From the investigations which have so far been carried out, it would appear that the thermal conductivity of grey cast iron varies from 0.110 to 0.140 and decreases with increase in temperature. The values obtained depend on the composition—silicon, manganese, nickel and vanadium lowering the conductivity, and chromium and tungsten raising it. The conductivity of white cast iron is considerably lower, varying from 0.030 to 0.080, and is also affected by composition. Heat-treatment, which produces graphitisation either in white or grey iron, influences the heat-conducting power of the material, the value being increased. The electrical conductivity of grey and white cast iron is also low, and is affected by composition and by special element additions in a somewhat similar manner to the thermal property. The relationship between thermal conductivity and electrical conductivity, according to the Wiedemann and Franz's Law, holds with a fair degree of accuracy for white cast iron, but where graphitisation occurs either in white or grey iron, this relationship is altered, due to the different conducting powers of cementite, ferrite and graphite.

Wages in the Light-Castings Industry.

At a conference held in Glasgow last week between representatives of employers and Trade Unions in the light-castings industry, new wage proposals were considered in an effort to settle the dispute regarding wages. The parties failed to agree, and referred the matters under dispute to their respective constituents, with a view to a further conference. The employers demand a reduction of 6s. a week in the wages of piece-workers, 4s. a week in the wages of time workers, 2s. per week in the case of labourers and 2½ per cent. reduction in the percentage paid to bath workers. The employers state that foreign competition, especially in the production of household baths, makes it impossible for them to continue the existing rates. About 12,000 operatives in Scotland and England are affected.

Sand-Blasting and the New Silicosis Orders.

The rapidly-increasing use of sand-blasting in this country has brought foundries and engineering firms face to face with the grave problem of eliminating the fine dust that arises from blasting to enable them to comply with the new Silicosis Orders that came into force last month. Insurance companies possibly are increasing the already high premiums for compensation insurances, and many firms will have to instal new plant. Messrs. Thos. Vickers, Limited, of 14, New Street, Birmingham, inform us that they have put on the market a new dustless flint-grit abrasive which, after some very searching tests, has been found to give the maximum of effective cleaning at a low air cost.

The annual Liverpool Metal Trade Golf Competition took place recently on the West Lancashire links, the winner being Mr. R. Bland, and the second prize being tied for by Messrs. W. Kerfoot, H. A. Scott-Barrett and K. Bates.

Some Considerations and Tests for Cast Materials for High-Temperature, High-Pressure Service.

By L. W. Spring, Chief Chemist and Metallurgist, Crane Company, Chicago, Ill.

[AMERICAN EXCHANGE PAPER.]

(*Continued from page 404, vol. 44.*)

Some Observations of the Effect of Prolonged Temperature.

Test was made of various metals under temperatures of 400 deg. C. to determine the corrosive action of steam atmosphere, as well as any possible deterioration due to prolonged temperature without stress. Bars of various materials, which might be applicable, were retained by a special fitting in a main line carrying high-velocity steam at 600 lbs. per sq. in. pressure and 400 deg. C. temperature. A record of these materials is given in Fig. 19 after 26 months' continuous exposure. While these test-pieces

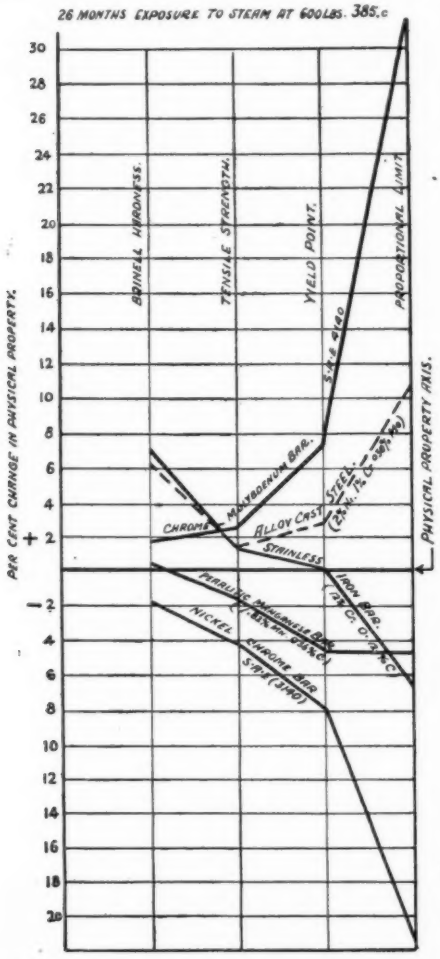

FIG. 19.—EFFECT OF LONG-TIME EXPOSURE TO HIGH-TEMPERATURE STEAM.

were not under any tensile stress, it will be noted that, due apparently to the seasoning action of steam temperature, they divided into two groups, one group gaining in hardness, tensile strength, yield point and proportional limit, the other showing loss.

The Effect of Molybdenum on Temper.

The effect of molybdenum in cast steel is very interesting. A number of years ago personal heat-treatment tests showed what might have been expected from knowledge of the effect of molybdenum in some other products, notably high-speed steel; that, either in chromium-nickel steel or in steel containing 1 per cent. chromium alone, and undoubtedly a considerable list of others, even a small content of molybdenum puts the tempering range up 111 or 139 deg. C.; thus, a water-, oil- or air-quenched nickel-chromium steel with a hardness of 350 Brinell or more, with 0.2 or 0.3 per cent. molybdenum, requires 675 to 705 deg. C. to temper instead of only 538 deg. C., which will bring about the same softness of 230 Brinell, if no molybdenum is present. In these days of high-temperature application of steels, when temperatures of 538 deg. C. are common, it makes considerable difference whether temperature of 675 deg. C. is required to "draw" the temper of the steel or whether it tempers readily at 538 deg. C.

Are Castings Stiffer?

It appears that castings are stiffer at temperatures lower than the equi-cohesive point. It had been customary, when sales were large enough to warrant the cost of forging dies, to manufacture forged flanges of exactly the same pattern and dimensions throughout as the regular cast flanges. It seemed to be satisfactory to most customers to receive the somewhat smoother and prettier forged flanges, even on orders for cast flanges. It was something of a surprise when two or three customers stated that they admired the forgings, but that, while castings of this size always had remained true under the high pressures which they used, the new forgings distorted under the high stresses, and, therefore, they must have the cast variety. Investigations showed that their contention was correct. The steel used for the forgings was changed so that an equivalent carbon was provided in the forged flanges. However, there still apparently remained a small difference in the flanges in resistance to bending. Just what relation this lack of stiffness in forged steel bears to differences in resistance to creep at higher temperatures, if any, has not been fully determined.

Comparative Rates of Corrosion.

This Paper is not intended to be an eulogy on steel castings, as might be inferred. However, castings have points of known superiority and advantage, and other points of advantage less well known, which should be brought to mind and at some time made the subject of a complete investigation. For example, it is learnt from users here and there that castings are preferred to forgings because they last somewhat longer under corrosive conditions. It may be that it is the continuous and usually the somewhat more dense skin layer of the casting which is bestowing the corrosion-resisting properties.

There is an aspect in this matter of solubility which sometimes is overlooked. This is the effect of any sponginess which occurs in castings, and the typical tendency of rolled metal to seaminess, cracks or unsoundness due to insufficient discard of the piped part of the ingot. It can readily be seen that a continuous surface of any product resists corrosion far better than a surface which has seams or sponginess due to insufficient cropping of the ingot, or, in the case of castings, sponginess due to shrinkage spots, etc. Acids or other corrosive media very naturally penetrate such seams or unsound spots and soon fill the spongy cavities of castings. This gives a greater amount of surface for the corroding media to work on, with the inevitable effect that the article fails very rapidly. To hold corrosion to a minimum, it is necessary that the corroding media have only sound and continuous surface upon which to work. It is possible, of course, that the somewhat higher-silicon content of the casting over the usual forged and rolled material exerts some influence in the matter of resistance to corrosion.

Confirmatory Practical Tests.

At first, though, it might seem that the laboratory or technical man is showing a little faith in his own results when he urges confirmation of research results through a more practical test before announcing the success of an alloy or an experiment. One must maintain that this is not so. While the tensile test proves quality quite conclusively through high yield point, good percentage of elongation and reduction of area, it often is desirable that some very practical test be made to show the properties of a casting or product in a direct way. For this purpose, beside the machining, finishing and hydraulic testing of such an article as a valve, one or two

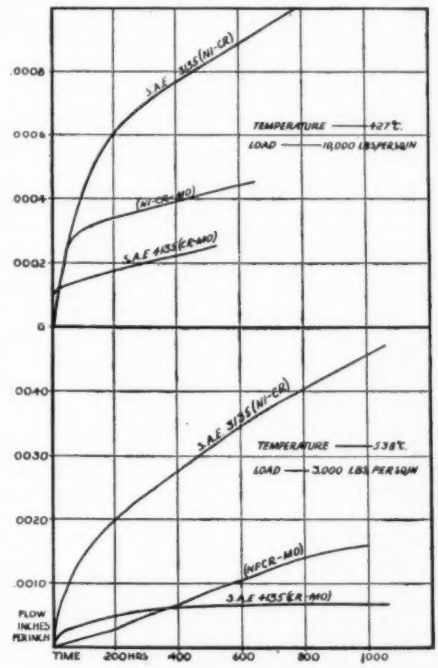

FIG. 20.—EFFECT OF MOLYBDENUM ON "CREEP RATES."

rough castings from the annealing or heat-treatment load may well be taken and broken under ball-drop test. Test begins with comparatively light blows, and the force of the blow is increased. By using several medium blows instead of a heavy one, the best chance for observation of the performance of the casting is given.

There are many angles to the development of new materials and particularly to their successful application to the manufacture of a highly-developed product. When the product is pipe, valves and fittings, or any one of the several accessories which go into the modern high-temperature, high-pressure plant, the qualifications which must be satisfied before full approval is given become quite numerous.

In developing for or applying new types of castings or other products to high-temperature service, laboratory-developed information should be followed by tests made in a very practical way, of which the above is one, not only to confirm and make sure that the results on small specimens used at first really apply to large-scale production, but to collect and make avail-

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able the data for practical shop purposes. While the modern method of having a large manufacturing organisation divided into separately-controlled units, such as research laboratory, control laboratory, foundry, forge shop, heat-treating factory way, since it gives a continuity of co-operative supervision from the laboratory metallurgist, who naturally has a keen interest in the introduction of his alloy into the production end, whereas otherwise it might fail. It also ties the sometimes less-practical laboratory metallurgist into closer harmony with the operating man, and, to a considerable extent, educates both to the necessities of the case, interests both, which is a very great advantage from to-day's standpoint of efficient development and production. Naturally, there are laboratory metallurgists and shop superintendents who do not, and perhaps cannot, work together, but in such cases considerable efficiency is lost.

FIG. 21.—CORROSION-TEST APPARATUS FOR SMALL ALLOY SAMPLES IN VARIOUS PETROLEUM VAPOURS, CONSISTING OF A 10-IN. PIPE RETORT WITH GAS BURNER BELOW, CAPABLE OF 200 LBS. PER SQ. IN. OIL-VAPOUR PRESSURE AND 344 DEG. C.

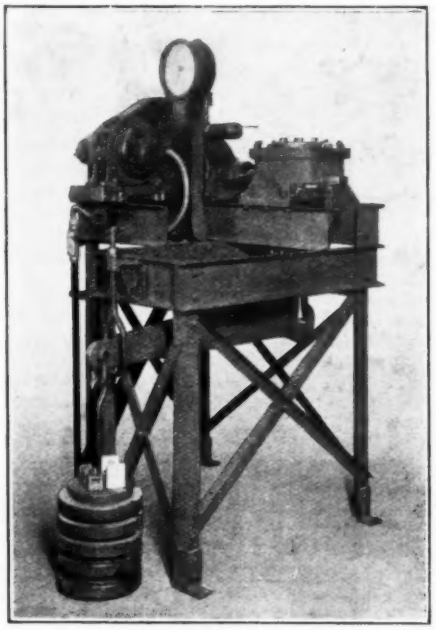


FIG. 23.—SCORE-TESTING MACHINE FOR TESTS OF VARIOUS COMBINATIONS OF METALS, AT VARIOUS TEMPERATURES AND IN PRESENCE OF VARIOUS CORROSIVE MEDIA.

department, etc., has advantages, there also is advantage in the other type, usually the somewhat smaller organisation, which has not become so completely dismembered that the foremen lose contact with each other, and, what is worse, contact with the whole job and knowledge of all conditions. To this end, there are advantages in allowing the competent investigator who developed the alloy, for instance, to follow it into the foundry. In one of the ordinary plant furnaces, a heat or two of the material should be made on a practical scale. From this should be made test-pieces for tensile, bend, impact, fatigue, high-temperature testing, small ingots should be cast for forging, together with castings of various sizes and shapes, etc. The ingots should be cropped, annealed and chipped and sent to the forge shop for a practical test under routine forging conditions. Gates and risers should be cut from the castings and the latter should be annealed or heat-treated according to previous experience; they should be cleaned and sent to the shops to be rough tested, machined, assembled and the product scrutinised in the normal way.

In other words, this semi-commercial test should follow the research work done on new or laboratory product to confirm or controvert it. This will show whether the material will or will not withstand the stress of actual manufacturing methods. It would seem that such alignment between the laboratory development and the shop development is seldom practised in quite as direct a way as is advisable. The very large plant has difficulty in doing it. The small plant seldom has occasion to operate both from the laboratory-development standpoint and that of shop production. However, where it can be done, it apparently is a particularly satis-

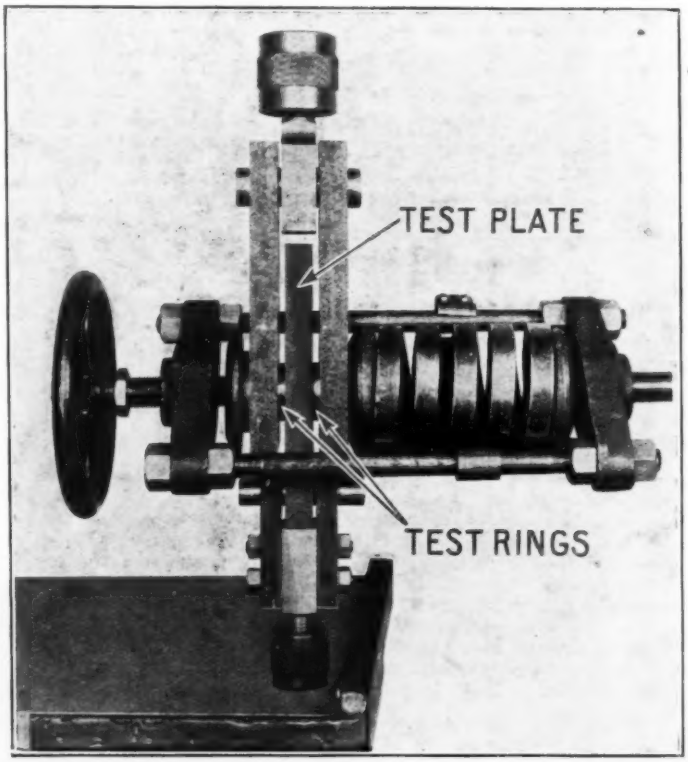


FIG. 22.—SCORE-TESTING DEVICE FOR USE IN TENSILE MACHINE.

After a successful, small-sized, practical tryout through the forging, casting, machine and assembling shops, the product can be said to be well on its way to becoming an article of manufacture. The engineering, cost and sales departments get much information from such practical test, even though only once made. From this information they can estimate better what must be done to put out the product at a profit than can be deduced from a small laboratory test.

Development of Modern Product for High-Temperature Service a Many-Angled Job.

Much experience, thought and experimenting must go into to-day's successful product. In the matter of satisfactory seating-metal for a valve, the following list may be put forth as covering only part of the qualifications which must be satisfied: (1) Non-corrosiveness; (2) proper coefficient of expansion; (3) forging or casting quality; (4) machinability; (5) density and smooth texture; (6) proper strength and ductility; (7) hardness sufficient to withstand scratching; (8) non-galling or seizing quality, and (9) reasonable cost. In the gate valve, for instance, the passage of fluid through the valve is controlled or closed off by the disc or gate being forced across the opening, which is called the "run." Naturally the flow of a fluid, such as steam, gas, oil, etc., must be stopped entirely, that is, without leakage. Therefore, in the first place, the disc or gate, as well as the abutting portions of the body of the valve, must be faced with rings, so smooth and well-placed that, even under high pressures of steam or penetrating gases, they will allow no leakage. Naturally, in order to remain satisfactory, they must be made of non-corrosive alloys, for any rusting or roughening by any sort of corroding media soon will cause the valve to leak.

Coefficient of Expansion.

The coefficient of expansion under heat, of these rings or facings must be approximately the same as that of the body or disc metal into which they are fastened, otherwise they become loosened instead of remaining tight in their places. A classic illustration of this was a test of threaded rings of copper-tin bronze screwed into the threaded openings of heavy cast-iron flanges. These assemblages were put into an oven and heated for a period each day to 427 deg. C. and then allowed to cool. After only two or three days, the bronze rings, which had been screwed in very tight by machine, could be unscrewed easily with the fingers, and longer tests resulted in the rings becoming very loose in the flanges. The reason, of course, is that the bronze, having a coefficient of expansion of approximately 0.000018 in. per degree C., tried to expand under the increasing temperature against the much stronger ring of cast iron, which expanded not so fast, nor so much, the coefficient of expansion of the latter being only 0.000012 in. per degree C. Therefore, the expanding, weaker bronze rings compressed themselves against the outer flanges. Although tight when hot, the rings when cold could not occupy the same space which they formerly had occupied, and, therefore, were loose. Other instances of this kind take place in heating metals of dissimilar expansion under high temperature.

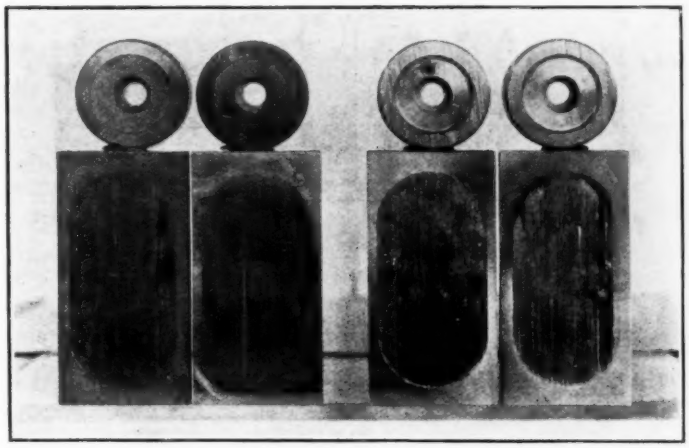


FIG. 24.—SCORE-TEST SPECIMENS.

Seizing or Galling.

Besides the fulfilment of expansion requirements, there must be proper strength and ductility in the alloy and a freedom from seizure of surfaces which would result in abrasion or "galling." This latter is a very serious matter, since it is impossible to keep a valve tight with seats which have become abraded to any considerable extent. Some metals have a predilection to gall, while others are less inclined to do so. Ten or more years ago the brasses and bronzes which were used for seating metals for less-high temperatures, nickel, Monel metal, and other nickel alloys, gave very good satisfaction as seating metals. However, with the advent of the recent higher temperatures and pressures, they are much less satisfactory. A 16-in. valve, for instance, under 900 lbs. pressure applied to one side only of the disc, gives between 5,000 and 6,000 lbs. per sq. in. pressure of disc seat against the body ring seat on the efflux side. When metals slide against each other under such pressures, the condition is a serious one, no matter how highly they are machined or polished. Undoubtedly hardness of the alloys has a profound bearing upon the avoidance of galling, but some metals, even though quite hard, do gall. While the use of dissimilar metals, instead of two like ones, helps the situa-

TABLE I.—*Analysis of the Ferrous and Non-Ferrous Metals Used.*

	Si.	Mn.	S.	P.	C.	Ni.	Cr.	Mo.	W.
FERROUS METALS.									
Cast steel, carbon	0.24	0.60	0.033	0.032	0.20	—	—	—	—
" "	0.34	0.77	0.029	0.032	0.33	—	—	—	—
" "	0.32	0.70	0.015	0.022	0.40	—	—	—	—
" Ni-Cr	0.28	0.57	0.015	0.011	0.40	2.03	0.82	0.23	—
" "	0.29	0.58	0.010	0.017	0.41	2.00	0.87	—	—
Open-hearth iron rod	0.03	0.02	0.028	0.008	0.01	—	—	—	—
Low C steel rod	0.02	0.47	0.037	0.004	0.17	—	—	—	—
Medium C steel rod	0.06	0.64	0.024	0.012	0.35	—	—	—	—
" " forged	0.06	0.53	0.048	0.021	0.41	—	—	—	—
Nickel-chrome steel	0.25	0.56	0.015	0.013	0.46	1.34	0.50	—	—
" " "	—	0.63	0.028	0.054	0.31	1.18	0.63	—	—
Cr-Mo steel	0.24	0.48	0.017	0.011	0.37	—	0.91	0.24	—
Stainless iron, 12 per cent. Cr	0.32	0.56	—	—	0.12	—	12.23	—	—
Austenitic Cr-Ni steel, forged	0.43	0.51	—	—	0.10	9.35	19.82	—	—
" " " Rolled	0.70	0.50	—	—	0.04	9.74	19.02	—	—
" " " Forged									
Cr-W steel	0.97	0.33	—	—	0.57	—	6.44	—	6.63
					Gr. C.	C.C.			
Cast iron	2.38	0.67	0.115	0.64	3.01	0.47	—	—	—
Ferro-steel	1.68	0.77	0.115	0.34	2.82	0.48	—	—	—
Malleable iron	0.75	0.53	0.187	0.15	—	—	—	—	—

	Sn.	Pb.	Cu.	Fe.	Zn.	Ni.
NON-FERROUS METALS.						
Bronze	12.25	0.01	86.21	0.01	1.46	—
	11.86	0.17	85.52	0.01	1.29	0.09
	5.99	2.33	86.28	0.06	5.10	0.23
	5.87	2.06	86.24	0.03	5.77	—
ANALYSIS OF METALS IN WEAR TESTS.*						
Forging brass	Trace	2.74	57.83	0.07	39.30	None
Naval bronze	0.75	None	57.90	0.03	39.21	None
Red brass, cast	5.63	2.71	85.17	0.06	6.26	0.12
Bronze, cast	11.98	0.16	86.35	0.01	1.36	0.10

* See page 401, vol. 44.

TABLE III.—*Consideration of Creep from the Approximate Limiting Temperature Standpoint.*

Material.	Approximate temperature in deg. C. permitting creep of		
	1 per cent. in 10,000 hrs. at 11.1 tons per sq.in.	1 per cent. in 10,000 hrs. at 1,000 lbs. per sq.in.	Range.
Open-hearth iron	221	620	399
Low carbon steel (0.15 to 0.25 per cent. C)	371	620	249
Medium carbon steel (0.3 0.4 per cent. C)	413	565	154
Heat-treated alloy steel No. 1 (0.40 per cent. C)	371	552	181
Heat-treated alloy steel No. 2 (0.40 per cent. C)	440	620	180
Heat-treated alloy steel No. 3 (6.5 per cent. Cr–6.5 per cent. W)	454	650	196
Austenitic nickel-chrome steel (18 per cent. Cr.–8 per cent. Ni)	510	871	361
Chromel (80 per cent. Ni – 20 per cent. Cr)	510	843	333
Carbon cast steel (0.25–0.35 per cent. C)	371	593	222
Ni-Cr cast steel (0.40 per cent. C)	454	607	153
	At 6.7 tons per sq. in.		
Rolled naval bronze	163	288	125
Cast red brass	204	427	223
Cast bronze	232	399	167

tion somewhat, the problem has not been satisfactorily solved. High temperatures, of course, complicate the situation, as also does the presence of certain of the fluids conveyed.

plished by a heavy railway spring which was compressed by a screw to give a pressure of 5,000 or more lbs. per sq. in. With such load compressing the pieces for test, the tensile machine

that is, the direction of motion could not be alternated. Another serious drawback was that test under various temperatures was quite difficult to accomplish with this apparatus. Still

TABLE II.—*Short-Time Tests on Cast-Steel Samples previously Tested in Creep.*

Material.	Group.	Flow test history.							Temp. of short-time test deg. C.	Tensile strength tons/sq. in.	Yield point tons/sq. in.	Proportional limit tons/sq. in.	Elong. in 2 ins.	R.A. per ann.
		Temp. of Long-time time test deg. C.	Time under test in hours.	Testing Load lb./sq. in.	Total Flow in in./in.	Thickness of scale in in.	Rockwell Hardness. Original.	Rockwell Hardness. After.						
0.33 per cent. C steel	1	398	1,008	30,000	0.04	—	—	—	21	37.0	24.0	23.1	21.0	34.0
		593	1,008	4,000	0.00216	—	—	—	21	35.8	19.2	17.4	27.5	41.5
		—	None	—	None	—	—	—	21	37.1	19.4	17.7	25.0	38.5
	2	398	1,672	15,000	0.0009	—	—	—	398	32.5	12.7	8.1	28.0	42.7
		—	None	—	None	—	—	—	398	30.8	12.2	7.6	31.0	53.0
	3	482	7,368	7,500	0.00863	0.004	—	B 66.1	482	21.1	10.8	8.8	42.0	69.4
		482	1,824	7,500	0.00068	0.001	—	B 77.3	482	24.0	12.9	9.3	34.0	63.7
		—	None	—	None	—	—	—	482	25.4	9.8	7.7	37.0	63.0
	4	593	3,480	3,000	0.00172	0.0025	—	B 75.4	593	17.8	8.5	6.2	38.0	56.4
		593	1,008	3,000	0.00130	—	—	—	593	20.1	9.4	4.0	34.0	54.1
		—	None	—	None	—	—	—	593	20.0	8.9	3.5	33.5	59.0
0.40 per cent. C steel	5	482	504	4,000	0.00045	—	—	—	21	36.8	18.7	18.3	23.5	36.2
		—	None	—	None	—	—	—	21	36.1	16.8	16.0	24.0	34.7
	6	287	456	12,000	0.00031	—	—	—	287	33.3	13.1	9.5	23.5	27.0
		—	None	—	None	—	—	—	287	35.7	13.4	8.5	17.0	25.0
	7	427	984	10,000	0.00111	0.0004	—	B 76.6	427	28.7	12.0	8.2	31.5	50.6
		—	None	—	None	—	—	—	427	29.9	12.0	5.5	29.5	52.0
	8	482	504	5,000	0.00047	—	—	—	482	24.2	10.6	6.2	33.5	55.4
		—	None	—	None	—	—	—	482	25.9	11.1	7.0	32.0	59.0
	9	593	8,736	4,000	0.00295	0.003	C—7.3	C—22.6	593	18.0	11.1	7.0	34.5	44.0
		—	None	—	None	—	—	—	593	20.1	9.1	3.3	33.5	39.5
0.20 per cent. C steel	10	427	4,032	10,000	0.00113	0.0005	—	B 72.3	427	27.8	11.4	10.0	34.0	54.8
		—	None	—	None	—	—	—	427	27.0	11.0	6.2	32.5	56.3
	11	593	1,824	10,000	0.01116	0.001	B 74.0	B 72.1	593	17.2	9.4	7.7	41.5	62.8
		—	None	—	None	—	—	—	593	18.9	8.9	3.5	39.5	68.1
0.40 C 2.03 Ni 0.82 Cr 0.23 Mo	12	427	1,200	20,000	0.00058	0.0003	C 17.1	C 18.8	427	42.2	28.8	21.6	20.0	49.3
		—	None	—	None	—	—	—	427	42.3	29.5	20.1	22.5	57.5
	13	482	1,104	5,000	0.00050	0.002	—	C 16.6	482	36.1	25.4	18.4	23.0	58.0
		—	None	—	None	—	—	—	482	37.0	27.0	17.8	23.0	67.0
	14	593	1,008	3,000	0.00064	0.0002	—	C 14.1	593	27.8	19.6	18.7	27.5	71.8
		—	None	—	None	—	—	—	593	31.2	23.0	16.0	26.0	74.1
5.0 Cr 0.34 Mo	15	427/593	1,344	15,000	0.00712	0.0005	C 21.7	C 20.5	593	32.8	20.1	9.8	27.5	68.1
		—	None	—	None	—	—	—	593	32.1	20.1	7.1	29.0	74.6
0.94 Cr 0.34 Mo	16	371/593	1,056	30,000	0.01458	0.002	B 96.1 B 96.2	B 94.3	427	41.9	28.3	17.0	23.0	54.5
		—	None	—	None	—		—	427	43.2	28.6	23.2	22.5	56.6

The Wear Test in Tensile Machine.

Many tests have been made on combinations of similar and dissimilar metals to determine suitable ones for present-day and future-operating conditions. The first method of testing, shown in Fig. 22, was by means of a tensile-testing machine, in which two rings of metal for test, with finely-finished surfaces, were forced against a double-surfaced long plate of the same or another metal to be tested. This was accomwas operated to pull the double-faced plate along between the two discs, the perfect alignment of which was ensured by a self-adjusting non-rigid support.

Although giving much very valuable information, such as showing that cast alloys almost invariably scored or galled less than forged or rolled materials of the same composition, this method had certain disabilities. One of these, of course, was that only one passage of the plate past the rings could be provided for reasonably; another drawback was the large size and cost of the specimens.

TABLE IV.—*Effect of Molybdenum on Tempering Temperature.*

	Brinell hardness.	Tempering temp. Deg. C.	M.S. Tons per sq. in.	Y.P. Tons per sq. in.	E. Per cent.	R.A. Per cent.	Elastic ratio. Per cent.
Tested at 21 deg. C.—							
Without Mo.	232	493	53.8	36.5	21.0	47.0	67.9
With Mo.	234	698	52.9	38.0	20.1	43.4	72.0
Gain	—	205	—	4 per cent.	—	—	4.1 per cent.
Tested at 538 deg. C.—							
Without Mo.	—	493	23.8	16.8	28.0	56.5	70.5
With Mo.	—	698	30.8	22.4	25.5	71.0	73.2
Gain	—	205	29 per cent.	34 per cent.	—	26.0 per cent.	4.0 per cent.
	C.C.	Gr.	Si.	Mn.	S.	P.	Mo (added).
Composition	0.82	2.03	0.28	0.57	0.015	0.011	0.23

New Wear Testing Machine.

These difficulties were obviated through design of another testing machine (Fig. 23), which has the advantage of using reasonably small specimens, having a wide range of temperature control from low to high (538 deg. C. or more), as many alternations as is desired at the rate of 7,000 per day and the use at will of ordinary atmosphere, of steam, or of any gas or fluid. This, of course, includes oil or any lubricant if desired. On the other hand, by the use of standard-metal specimens it would be possible to use the machine for the opposite purpose of testing out oils or other lubricants.

While much work has been done, it is hoped that information will be gained eventually which will show the mechanism of the scoring under friction of the many types of metal tried, together with illustration of the effect on galling or scoring of various heat-treatments and of forging, rolling, etc. It will suffice at the moment to state that, in general, cast alloys score far less than the same materials in a rolled or forged condition; that cast alloys, and, par-

(*Concluded on page* 12.)

Modernising a Speciality Foundry.

The Fisher Malleable & Bronze Foundries, Limited, of Greet, Birmingham, was established in 1912, when the works consisted of a few cottages adapted to the needs of a foundry. The business started, in fact, at the very bottom of the ladder. Three cottages were rented at 4s. per week, two of which were let at a "profit" of 1s. per week, and the manufacture of brass and malleable castings commenced in an old stable in very primitive style. Rapid progress was made, and, in 1914, a field was purchased. The foundry built thereon was demolished in 1929 and replaced by the present modern well-lit foundry, specialising in castings for the cycle and motor-cycle industries and employing between 75 and 100 workpeople. Work for other trades requiring castings of more than average accuracy and intricacy and suitable for mechanical-production methods has also recently been undertaken.

Realising that the odds against efficiency are too great if every class and size of casting are attempted, it is the fixed policy of the management to limit the range of castings produced. With this aim in view, two sizes of boxes only are used on the moulding machines, viz., 12 in. by 18 in. and 14 in. by 14 in. Further, it is realised that greater efficiency can be obtained through cleanliness and well-lighted shops, and, in these respects, all departments excel.

Like most foundries, it has had to modernise by sections, and the directorate make no claim to have completed this work. Actually, radical modifications in the melting plant, which consists of cupolas by Alldays & Onions and Constructional Engineering Company, and the sand-preparing and handling plant, are under consideration. The former is about to be provided with mechanical means for elevating materials on to the platform, whilst an Eirich counter-current mixer, by O. Ullrich, G.m.b.H., Leipzig, with automatic loading device and central discharge into a disintegrator, is at present being installed to replace an old-fashioned sand mill. Overhead sand bunkers, with gates designed to feed the moulding machines with the precise amount of sand required at one discharge, together with the necessary elevating machinery, are being planned by the same firm but for manufacture in England. Other conveyors are also being installed to carry moulds to the pouring zone.

The main foundry building, the interior of which is shown in Fig. 1, has been constructed and laid out so that modification can be made at any time in the flow of work passing through, as, with the exception of a dozen crucible pit fires, mainly used for bronze melting, the whole of the floor is devoted to moulding and coremaking. A bay, which is not included in the main rectangle, is used for storing pattern plates and for the periodical overhaul of machines. A further bay is used for moulding bronze and gun-metal, chiefly for steam fittings and carburettor castings. Here, however, in contradistinction to the iron foundry, jobbing work is undertaken.

The coremaking department, employing at the time of our visit 15 hands, of which three only were males, is conveniently located at the back of the hand moulders opposite the main row of machine moulders, so that the baked cores emerge at a point exactly in the centre of the moulding floor and opposite the cupolas. Ordinary methods are employed, though the installation of pneumatic core-blowing machines is under consideration. The core sand is mixed in a paddle-type machine and cores are dried in a coke-fired oven designed and constructed by the company.

Some seventeen moulding machines are in commission. Those operated by hand include a hand-ram stripper, by Pridmore; squeezers, by Moline Iron Works, and squeezers with pin lift, by Herring & Son. The compressed-air machines installed include a plain squeezer, by Tabor; several jolt squeezers, by Nichols; simultaneous jar squeezers and twin plain squeezers; both falling into the last two categories have been designed by the company's own staff. As these machines present several novel features and are interesting on account of their extreme simplicity of construction and ease of operation, we have thought fit to include a technical description of their functioning.

A Novel Moulding Machine.

The general appearance of the machine is shown in Fig. 3. It is operated by air at 80 to 100 lbs. pressure which is supplied by a single-acting vertical compressor by Sir W. H. Bailey & Company, Limited, whilst a similar machine, by Berlin-Sächsische Maschinenfabrik u. Eisengiesserei, G.m.b.H., is held in reserve. The moulding machine is of the plain squeezer type with a 10-in. piston. One valve, centrally placed in convenient reach of both moulders, controls all operations. Long "V" slide rails are carried the whole length of the machine, which gives clearance for the ram in the centre. The mode of operation is for one moulder to fill and squeeze his mould whilst the other is coring and finishing. As, in practice, neither operator hinders the other, it is found that equal output is obtained from one twin machine as from two single machines.

Snap flasks are used wherever possible, the alternative being cast-iron boxes with $\frac{3}{4}$-in. round pins at one end and $\frac{3}{4}$-in. square pins at the other, with allowance for play lengthwise. This efficiently counters the tendency to bind which sometimes occurs when round pins only are used.

Most of the pattern plates are rapped by a small "Speedie" vibrator, another tool developed by the management of the foundry. About 1,000 vibrations per minute take place, as the blow is on one end of the vibrator only. It is considered that by this means a more powerful and effective blow is delivered as compared with the more usual type of vibrator in which the piston strikes both ends and gives about 2,000 vibrations per minute. The vibrator was originally devised for rapping the annealing pots during packing, which enables each can to hold from 5 to 10 per cent. more castings. Like most malleable foundries, a large collection of iron, aluminium and other types of pattern plates has been amassed, but recently Bakelite has been pressed into service with good results.

Instead of rumbling the hard castings, the sand-blast has been resorted to, and, for this purpose, a large barrel-type machine, by Vogel u. Schemmann, with two oscillating nozzles is used; also, a cabinet by Vereinigte Schmirgel u. Maschinenfabrik, A.G. Air for these machines is supplied by a horizontal double-acting compressor by the Ingersoll-Rand Company.

FIG. 1.—GENERAL VIEW OF THE FISHER MALLEABLE FOUNDRY.

FIG. 2.—VIEW OF THE SAND-PREPARING AND CORE DEPARTMENTS—FISHER MALLEABLE FOUNDRY.

Annealing Ovens.

Annealing is carried out in two 10-ton capacity ovens of the semi-gas-fired recuperative type, by Th. Teisen, furnace engineer, Birmingham. They are of a type understood to have been originally evolved by the Swedish General Electric Company. The castings are packed with West Coast iron ore into the usual type of Black Country pots in the actual furnace itself, the temperature of which is controlled pyrometrically. The annealing cycle found to be desirable

for the class of work produced is a fairly long one. It takes about 36 hrs. for the castings to reach a malleabilising temperature of from 900 to 1,000 deg. C. This heat is maintained for 120 hrs., whilst a further 24 hrs. is occupied in cooling down. The comparative slowness of the annealing cycle is reflected in increased malleability and machinability of the product, which is desirable for the trades that are principally catered for, though unnecessary for casting requiring little or no machining. A 5-ton capacity oven of a type common on the Continent is also used, and is highly satisfactory for certain classes of work. Here, the fire box is integral with the oven itself, being built across one end. Combustion takes place in the space above the fire box and the gas enters the annealing oven proper partly through ports in the dividing wall and partly over the top and exhausts into flues placed at floor level in each corner of the chamber. Here, the annealing temperature is reached in 16 hrs. A temperature of about 1,000 deg. C. is maintained, and the anneal completed in 120 hrs. with 24 hrs. in which to cool down. The fuel used is steam coal, slack and coke; the consumption averages 18 cwts. per ton of castings treated. The fuel consumption of the Teisen ovens is more favourable, varying between 5 cwts. 1 qr. and 11 cwts. per ton of castings annealed, the somewhat great discrepancy being due to wind and weather conditions. The ovens being built near a stream, the underground flues are subject to flooding and dampness. Previously, a battery of six direct-fired ovens, requiring hard spire coal as fuel, was used. These were condemned as uneconomical and demolished, the ratio of fuel to castings annealed being 2 to 1.

Large annealing pots, common to Continental practice, have been tried out, but with no great success; the cost of setting the largely-increased proportion of distorted castings more than offset the greater tonnage contained in the oven.

For cleaning the soft castings, both barrelling and sand-blasting are used, with a preference for the latter, whilst a small battery of heavy grinders with 24-in. wheels is used for removing the remains of gates and risers. The product is particularly soft, and, we would imagine, capable of being machined at high speed. It is pleasing to note that, at the time of our visit, there was plenty of work on hand; in fact, double shifts were being worked in the softening department and overtime in others was general. We realise that, for the motor-cycle industry in particular, many parts must be plated, and the securing of a surface suitable for this is an important feature, connected, no doubt, with a carbon-free skin.

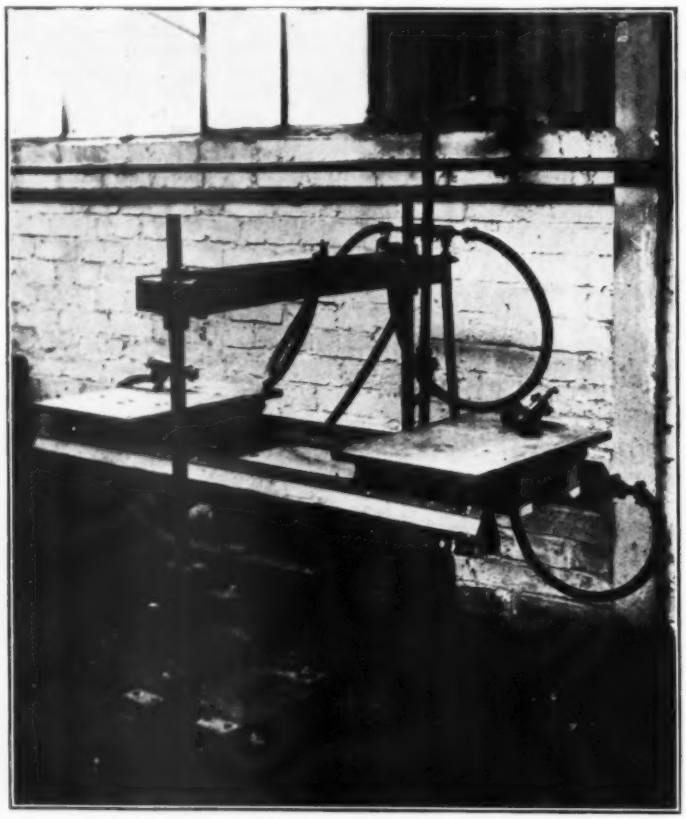


Fig. 3.—A Double-Squeezer Moulding Machine serving Two Operatives—Fisher Malleable Foundry.

We wish to acknowledge our indebtedness to Mr. Matthew Docker for the description of the twin-moulding machines in use in this factory.

The Institute of Metals.

AUTUMN MEETING IN ZÜRICH.

As previously announced, the annual autumn meeting of the Institute of Metals will be held in Zürich from September 13 to 15, by kind invitation of the Schweizerische Verband für Materialprüfing. There has been formed in connection with the meeting a local reception committee, of which Prof. M. Rös is chairman, and Dr. E. Honegger, honorary corresponding member to the Council for Switzerland, is honorary secretary. A ladies' committee has been formed, with Mrs. Rös as chairman and Mrs. Honegger as honorary secretary.

The headquarters of the Institute and the office of the honorary local secretary will be at the Savoy Hotel. The meetings will be held in the Federal Polytechnic (Eidgenössische Technische Hochschule). Following the meeting in Zürich, optional tours will be made to Lucerne, Thun, Biel (Bienne) and Chippis-Siders (Sierre) (September 16 to 18).

Prior to the meeting there will be held in Zürich, from September 6 to 12, the first congress of the New International Association for Testing Materials. Some members may desire to take part in this congress, also to visit the International Foundry Exhibition that is to be held in Milan at the conclusion of the Institute's meeting.

Programme.

On Sunday, September 13, the Tenth Autumn Lecture will be delivered by Mr. Ulick R. Evans, M.A., on "Thin Films on Metals in Relation to Corrosion Problems."

On Monday, September 14, there will be a general meeting of members in the Auditorium I. (E.T.H.), when Papers will be presented in abstract and discussed as time permits. Works visits will be made to (*a*) Kraftwerke Wäggital, Wäggital; (*b*) Eisen and Stahlwerke vorm. G. Fischer, Schaffhouse (malleable-iron and steel founders); (*c*) Alfred J. Amsler & Company, Schaffhouse (makers of testing machines), and (*d*) Escher, Wyss & Company, Zürich (electrical engineers).

On Tuesday, September 15, a second general meeting of members will be held, when Papers will be presented in abstract and discussed as time permits, after which the general meeting will be formally closed. Works visits will be made to the following: (*a*) Maschinenfabrik Oerlikon, Oerlikon (electrical engineers); (*b*) Brown, Boveri & Company, Baden (electrical engineers), and (*c*) Sulzer Brothers, Winterthur.

Some Considerations and Tests for Cast Materials for High-Temperature, High-Pressure Service.

(*Concluded from page* 10.)

ticularly, large-grained alloys and those which contain inter-metallic compounds (perhaps of a hard nature), seem to have greater resistance to scoring than those of finer grain and those without such compounds; that hardness seems to be a factor, as mentioned above, materials of greater hardness, other things being equal, scoring less than softer ones (Fig. 24). However, there apparently are definite ranges in which complementary alloys do not score much under even very heavy load.

It is realised that some of the topics of this Paper have been handled rather sketchily. It seemed desirable to do this in order to make it more or less non-technical. Much detailed information has been published by others regarding casting alloys and castings, which give various compositions, heat-treatments, physical properties and much other valuable information.

It appeared profitable to write this Paper as much as possible from the opposite or serviceability standpoint.

In creep and wear testing of these materials some peculiar phenomena have been encountered. It is too early to be entirely definite in discussing these, but they are mentioned as matters of interest and likely will be found to be of industrial importance. It seems highly desirable that some of our associations or groups of casting manufacturers take fully-planned and well-supervised steps to determine some of these things.

Appreciation is expressed to the members of the author's staff who have done most of the experimental work upon which these findings have been based, and to Messrs. H. W. Maack and J. J. Kanter who have assisted with the reading of copy.

Society of Chemical Industry.—This Society has now published the programme of the Jubilee celebrations and its 50th annual meeting during the week July 13 to 19 next.

Some Notes on the Structure of the British Foundry Industry.*

By Vincent C. Faulkner.†

Because of the fiscal policy which has been in operation in Great Britain for about a century, the author points out that the foundry industry is infinitely more varied than that of any other country in the world. Its system of free imports has had a profound influence upon the equipment of the industry, and thus one finds in most modern foundries a well-blended mixture of British, American, French, German and Belgian plant. On the other hand, there exist foundries which are virtually 100 per cent. British, American or French in their equipment.

Another phase of the British foundry industry is that during this period a very considerable export business has been maintained, which has resulted in the creation of foundries making castings which are never used in the country, such as those for the preparation of tea, sugar, rubber, oil, and for the market for various types of mining machinery. Thus, from the dual aspect of variety of equipment and production, Great Britain probably is unique.

Steel-Foundry Industry.

After dealing with the commercial organisation of the industry, its technical and scientific organisation, auxiliary organisations, recruitment and training of personnel, rationalisation, and other aspects of the industry, the author, referring to the steel-foundry industry, remarks that it is said that Hadfields, Limited, of Sheffield, is the largest steel foundry in the world. Continuing, he points out that there is no common method of melting used in British foundries, and the acid open-hearth, baby Bessemer, electric and crucible are all in use. The product of the small converter is accepted by all the national purchasing authorities as being equally good as electric steel. The author is not aware of any steel castings being made in acid-lined electric furnaces, although a firm in North Yorkshire may provide the exception.

The high-frequency induction furnace is being used in one Southern foundry for the manufacture of stainless and electro-magnetic steel castings, and is giving excellent service at a production cost comparable with that of, say, a 2-ton electrode electric furnace.

As Great Britain is subjected to the full blast of Continental competition, British steel foundries are forced to practice the most rigid economies in manufacturing methods. Detailed attention is given to preparation and handling of sand to the moulders. The welding of small defects in steel castings is not looked on with favour by buying authorities, and special permission invariably has to be obtained. Electric welding, using coated electrodes of specified composition, varying with each grade of casting, is the most popular type of outfit.

Loam composition, dry sand and green sand all are used in the making of moulds, while there is a lively competition between Belgian and British sand as the principle basis. Synthetic sand—that is, a mixture of pure silica sand and clay—is not extensively employed. Mould conveyors, beyond a length of roller pathway, have not yet been installed.

Malleable-Iron Foundries.

Although the consumption of malleable castings per head of population is probably lower in Great Britain than in any of the larger industrial countries, there are no less than 130 individual plants established. The best known is Ley's Malleable Casting Company, Limited, of Derby, which is the largest malleable-iron foundry in Europe. It manufactures American black-heart malleable, and in this detail differs from most British concerns, which operate on white or Réaumur iron. All the melting and heating operations are carried through by the use of pulverised fuel, while for moulding, sandslingers pulling four stripping machines in their wake are largely employed.

Another foundry utilises the residual heat from steel making in the electric furnace as an aid to the economic melting of a synthetic mixture of steel turnings, ferro-silicon and anthracite for black-heart malleable. The principal white-heart manufacturers still use the cupola, which, because of its ability to give metal continuously, helps to secure a comparatively large output from restricted floor space.

At the moment, much attention is being devoted to rotary pulverised-fuel-fired furnaces of the Brackelsberg and Sesci types. One installation is working with initial success in Yorkshire, and others are almost ready to begin operations. In so far as European conditions are concerned, the rotary pulverised-fuel-fired furnace is unique in being the only melting method ever offered to to the foundry industry which claims the same low cost of melting as in the cupola.

Non-ferrous Foundry Work.

Where non-ferrous foundries have been able to specialise on productions involving heavy expenditure on plant, control and world-wide selling organisation, the success achieved has been notable. For instance, manganese-bronze (high-tensile brass) propellers are made in London, and are exported to all parts of the world.

Other concerns making valves and bearings have little difficulty in maintaining full shops, no matter what conditions of general trading may be. A foundry in Yorkshire—David Brown & Sons, Limited, of Huddersfield—has been extremely successful in perfecting a system of centrifugal casting of bronze gear-wheel blanks.

In recent years, small oil-fired reverberatory furnaces have found increasing favour for non-ferrous melting. This probably has been due in some measure to decreases in the price of the virgin metals and oil fuel. When the raw materials of the non-ferrous foundry were expensive and erratic in price, a mistake in buying was sufficient to outweigh any reasonable economies in melting practice. The electric furnace is used also, the Ajax-Wyatt and the Ajax-Northrup being the most popular types.

The Birmingham Aluminium Casting Company has probably the largest output of any light-alloy foundry in Europe. An associated company, Sterling Metals Company, Limited, easily leads the field as the largest producer of magnesium castings in England, with a monthly production varying between 40 and 45 tons. To visualise just what this means, similar castings made in grey iron would weigh approximately 200 tons. Moulding is carried out by a sandslinger, and sulphur is incorporated in the sand used. Great progress has been achieved recently in the production of Alpax or silumin alloy.

Pipe Founding.

The pipe business has been concentrated into the hands of less than half a dozen firms They represent true pictures of simple vertical trustification, as they possess their own blast-furnaces, iron-ore mines, coal pits, coke ovens and perhaps even their own limestone quarries. The largest maker of cast-iron pipe in Europe is the Stanton Ironworks Company, Limited, with an output of over 300,000 tons per annum. A large percentage of this production is made by the DeLavaud process, which incorporates a system of centrifugal casting under specified methods of mould filling.

The Staveley Coal & Iron Company Limited, are putting into operation a large plant for the manufacture of sand-spun cast-iron pipes, a method developed by the American Cast Iron Pipe Company, of Birmingham, Ala. The products from these works find a ready market throughout the world.

The author finally refers to automobile foundries, the production of light castings, textile-engineering foundries, shipbuilding and other foundries.

* Extract from the Annual Exchange Paper of the Institute of British Foundrymen to the American Foundrymen's Association, presented at the Chicago Convention.

† Past-President, Institute of British Foundrymen.

A Visit to Castlecary Firebrick and Silica Works.

As briefly mentioned in our issue of June 4, members of the Falkirk Section of the Institute of British Foundrymen recently inspected the Castlecary works of Messrs. John G. Stein & Company, Limited. The party was received by Colonel Alan Stein and Mr. Norman Stein, and they, with members of the staff, conducted the visitors through the various departments.

The research laboratory was first visited. This is a new building, very well equipped, and consists of a furnace room, physics room, chemical laboratory, microscopy room, dark room, library and offices. In the furnace room the equipment is very full, consisting of various types of furnace capable of giving very high temperatures. In some of these the refractoriness of samples from stock was under test; in others, the refractoriness of bricks under various loads was being examined. Any new product is carefully tested here before being put into production, and, even when on a productive basis, routine tests are constantly made to ensure that the quality of the ware is maintained.

In the chemical laboratory, daily analyses are made both of raw materials and of finished products. The microscopy room and dark room are evidences of a modern conception of the value of research; here the actual structure of the fired refractory can be observed, and evidence given of the correctness of the firing. Microscopic examination is of particular value in the case of silica bricks, which, unless fired at the correct temperature and for a sufficient length of time, will fail under use, due to after-expansion.

In the physics room, further tests of the fired goods are made; if a firebrick be fired correctly, there should be little or no contraction when the brick is in use at high temperatures, and this is checked by heating samples out of stock under working conditions, and their contraction (or expansion, in the case of silica bricks) at various temperatures noted. The apparatus can be made self-recording, so that no error on the part of the observer is possible.

Brickmaking.

Leaving the laboratory, the visitors were shown the preparation of the clay. It was seen as received from the mine, then mixed with grog, pugged into the correct consistency, and then passed to the brickmaking machines. The whole plant is a striking demonstration of how careful lay-out of machinery has ensured constant production with low maintenance cost. The brickmaking machines are remarkable in construction; in three operations the lump of pugged clay is turned into a brick of uniform size and texture. Seeing one of these machines in operation makes the observer realise how an output of 1,000,000 bricks per week is possible.

The hand-moulding of special shapes was then examined, and also the pattern store; and the store itself is larger than many foundry-pattern stores. The raw or "green" bricks were then followed to the 1,000-ft. long, semi-continuous

(*Concluded on page* 15.)

XUM

Institute of British Foundrymen.

FIRST ANNUAL REPORT.

In our report of the recent Birmingham Convention of the Institute of British Foundrymen, we noted that MR. F. W. FINCH, one of the founders of the Institute and its first honorary secretary, was invited by Mr. F. P. Wilson, J.P., the retiring President, to give a short account of the Institute's first meeting, in order that the members should not forget the circumstances in which its work commenced. Mr. Finch read to the meeting his first report, which he had presented at the first annual convention, held in the Chemical Lecture Theatre, Owens College, Manchester, on August 2, 1904. This report we reproduce below.

The Institute's First Report.

"It will, no doubt, be remembered by a few of those present who read the FOUNDRY TRADE JOURNAL that a correspondence was carried on in that journal for several months *re* an English foundrymen's 'association,' somewhat on the lines of the American Foundrymen's Convention.

"A very able article was written on the subject by Mr. Percy Longmuir, who, I am pleased to say, is with us to-day, and several others wrote on the same subject. Feeling that we might keep on writing for another twelve months if someone did not take the initiative, on the advice of Mr. John G. Stewart, of Urmston, I wrote to the editor of the journal asking him for the names and addresses of those who had written on the subject, so that I could write them. The editor supplied me with the names, and I at once wrote them all, asking if they would form themselves into a committee to put the convention into shipshape. They all replied to my letters, but several could not, on account of circumstances, join.

"Having got the names of several persons—our President being one of them—I called them together on Saturday afternoon, April 9, at the Cobden Hotel, Birmingham. Those who answered the appeal and attended the meeting were:—Messrs. R. Buchanan, C. Morehead, J. Ellis (Woolston), F. J. Cook, F. W. Shaw and W. Vickers—not a very large number, but sufficient to set the association in motion. Mr. R. Buchanan was elected President. The rest of those present formed themselves into a committee, with power to add to their number. I had the honour of being elected hon. secretary and treasurer. A circular was drawn up at that meeting which no doubt most foundrymen have seen, setting forth the advantages of such an association. When I got back to Gloucester, 3,000 such circulars were printed, and they were sent to those interested in the foundry business, taking the annual report of the Moulders' Society which gave the addresses of nearly all the foundries in England, Ireland and Wales. Circulars were sent to all firms employing more than five moulders. After getting these away by post, I set to work to get the addresses of the Scottish firms.

"This proved rather more difficult, but, having got the address of Mr. Jack, secretary of the Scottish Moulders' Society, I wrote him, asking if he would give me the addresses of the Scotch foundries. He very willingly replied and wished us every success in the establishment of the association. The best information I received was from one of our committee, Mr. W. Roxburgh, of Kilmarnock, who classified the addresses for me.

"Having got these circulars sent away, results followed which, in the opinion of the committee, and, I hope, of this convention, have been very satisfactory. This will be appreciated when I tell you that we have now enrolled 94 members, which include the whole of the United Kingdom—77 from England, nine from Scotland, six from Wales and one from Ireland, and one from India. The finances are also very satisfactory, as the whole of the 94 members have sent their subscriptions, making a total of £35 5s. Our expenses have been £18 12s. 7d. We have in Gloucester branch of the Capital and Counties Bank, £12 2s. 6d.; and in the hands of your treasurer, £4 9s. 11d.; making a total balance of £16 12s. 5d. for future requirements.

"Sending out circulars and receiving remittances has not been all the work required, for the correspondence in connection with the association has been very heavy, many persons writing several letters before becoming members, asking for more information than the circulars gave. I endeavoured to give the best information that was possible, and suppose it has been satisfactory, as the majority of them have become members of the association. Other correspondence has been in sending information to the different journals in the engineering trade. Many journals gave some information respecting our association, and I am pleased to say it has not been without result, having had several applications from readers of those journals. I also sent a letter and one of our circulars to the American paper, 'The Foundry,' which gave us a very good report. One result of that was a letter from the secretary of the American Foundrymen's Association, which reads:—

'DEAR SIR,

'I learn with much pleasure of the formation of a British Foundrymen's Association, through our American technical Press. Also the splendid compliment you give us in the announcement. Believe us that we are very grateful, not only for the courtesy involved, but for the knowledge that the hard work and effort we have given to the cause here in the face of disheartening apathy on the part of nine-tenths of the entire industry, who should jump at the chance to be benefited, is appreciated in other countries. We should like to cultivate close relations with your association, and I beg you to count on us in anything which our means allow to help along any lines of investigation of value to the founders of both continents. I am sending you some literature we have gotten out recently, and will also send you as complete a set of our older publications as I can scare up. I also trust that you will put us on the mailing list, and hope for much and mutually profitable intercourse.

'Faithfully yours,
'RICHARD MOLDENKE.'"

I.B.F. Elects New Members.

At a Council meeting of the Institute of British Foundrymen, held at the Grand Hotel, Birmingham, on June 9, 1931, the following were elected to the various grades of membership:—

As Subscribing Firms.

A. F. Craig & Company, Limited, Caledonia Engineering Works, Paisley; Grangemouth Iron Company, Limited, Grange Iron Works, Falkirk.

As Members.

A. C. Brown, steel founder, Carntyne Steel Foundry; G. W. Brown, foundry manager, Austin Motors; E. Carey-Hill, director, Rowland Hill & Sons, Limited; J. B. Fenwick, S. W. B. Stephen & Company, Limited; A. E. Hobday, foreman, Metal & Steel Factory, Ishapore, India; D. M. Moir, branch manager, W. Jacks & Company; H. J. Roast, director, Roast Laboratories, Montreal, Canada; L. P. Sidney, Editor, "Iron and Steel Industry"; L. V. Stanton, works manager, Gibbons Bros., Pennett; W. Vickers, sales department, I. & I. Walker; E. J. Yates, manager, Goldendale Iron Company, Tunstall.

As Associate Members.

J. Blackiston, engineer, Dorman, Long & Company, Middlesbrough; F. G. Dowse, foundry general foreman, Morris Motors, Limited; F. A. Hake, foundry chief clerk, Morris Motors, Limited; H. Holroyd, technical manager, Coventry Malleable & Aluminium Company; L. B. Hunt, assistant chemist and metallurgist, Vauxhall Motors, Luton; E. C. Hutchings, foundry foreman, Morris Motors, Limited; C. W. Jones, technical assistant, Bradley & Foster, Limited, Darlaston; E. Morris, foundry foreman, Revo Foundry Company, Tipton; A. D. Sharratt, foundry charge hand, Daimler Company, Limited, Coventry; R. A. Stiles, technical assistant, Bradley & Foster, Limited; R. H. Yates, moulder, Metropolitan-Vickers Company, Limited.

International Congress for Testing Materials.

The first congress of the New International Association for Testing Materials is to be held in Zürich from September 6 to September 12. The chairman of Group A—Metals, is Dr. Rosenhain, F.R.S., and he has used his great influence to ensure that grey iron takes a prominent position in the proceedings, as a survey of the list of Papers to be presented will show.

Papers to be Presented.

"The Structure and Mechanical Properties of Cast Iron," by J. G. Pearce, M.Sc., Director of the British Cast Iron Research Association.

"The Question of Testing Cast Iron," by Dr. Ing. E. Dübi.

"Evaluating the Mechanical Properties of Grey-Iron Castings," by A. Portevin.

"Testing Methods for Grey Iron," by Dr. Ing. E. Piwowarsky.

"Tests on Cast Iron," by Dr. Ing. F. Pisek.

"Materials at High Temperatures," by Prof. F. Fabry and Ing. W. Pfaff.

"Metals at High Temperatures," by Dr. J. Galibourg.

"Materials at High Temperatures," by R. G. Batson and H. J. Tapsell.

"Fatigue," by Dr. D. J. McAdam.

"Fatigue," by Dr. Ing. P. Ludwik.

"Present State of the Knowledge of Fatigue of Metals," by Dr. H. J. Gough.

"On the Evolution of Stress Testing in Germany," by Dr. Ing. E. Schulz and Dr. Ing. Buchholz.

"Accelerated Tests for the Stress-Range Evaluation of Steels," by Dr. Ing. A. Pomp and Dr. Ing. W. Enders.

"Resilience Testing as a Method of Inspection," by Ing. A. Steccanella.

"Notched-Bar Tests and their Standardisation," by Dr. Ing. M. Schmidt.

"Meaning of Notched-Bar Impact Test for Investigation and for Acceptance Test Purposes," by Dr. R. H. Greaves.

"The Present Position of the Notched-Bar Impact Testing in Germany," by Dr. Ing. Moser.

"Notched-Bar Impact Testing," by Prof. R. Zoja.

"Advances in Microscopy," by F. F. Lucas.

"Progress of Metallography," by Dr. J. L. Haughton.

"New Conceptions of the Constitution of Alloys," by Prof. W. Guertler.

"Progress in the Knowledge of Slag Inclusions in Iron and Steel," by Prof. C. Benedicks.

"X-Ray Investigations of the Constitution of Alloys," by Prof. A. Wistgren.

It should be clearly understood that this Association has not assumed any legislative power, and its deliberations are suggestive and designed to present to the world the position adopted by the scientific minds of the various countries, commercial and industrial questions being outside its scope.

TWO ORDERS for electrical machinery of the total approximate value of £165,000 have been placed with the Metropolitan-Vickers Electrical Company, Limited, Manchester. One order is for a 26,000-kw. turbo-alternator, and has been placed by the Rhodesian Government. The other order is for a 15,000-kw. set for the Norwich Corporation.

Trade Talk.

IN PREPARATION FOR THE Falkirk Trades Holidays, the Carron Company Works Holiday Fund has been disbursed. Employees participated in a share-out of £5,250.

EMPLOYEES OF THE Singer Manufacturing Company, Limited, Clydebank, have subscribed £502 during the past three months to infirmaries and other charitable institutions.

MESSRS. FLEMING & FERGUSON, LIMITED, Paisley, launched a twin-screw hopper dredger recently, built for the Government of Madras. The vessel has a capacity of 600 tons and a speed of 9½ knots.

MESSRS. YARROW & COMPANY, LIMITED, Scotstoun, have received an order for two Yarrow patent water-tube land boilers, with superheaters, economisers and mechanical stokers, for the new electricity undertaking at N'Dola, Northern Rhodesia.

BY AGREEMENT BETWEEN the Sheepbridge Coal & Iron Company, Limited, and Messrs. Parson, Limited, of 111, New Street, Birmingham, Mr. George M. McMinn will represent the Sheepbridge Company as from July 1 as their direct agent in the Lancashire area.

IN ACCORDANCE with the recommendation of the Indian Tariff Board that the revenue duty on pig-iron need not be removed, the Government of India desire to take no action in regard to the duty, and have now published the report, which, in fact, had been submitted to them about two years ago. The Board observe in their findings that there will be another opportunity of going into the subject when the statutory inquiry into the steel industry takes place in 1933-34, or earlier.

TO STIMULATE OVERSEA TRADE, British Insulated Cables, Limited, of Prescot, have prepared a cinematograph film for exhibition in South America, Australia, New Zealand, India, South Africa and other countries, designed to show the perfection of the methods of manufacture and of research which have made British electric cable recognised all over the world as representing a high standard of efficiency and endurance. The film was exhibited in London last week.

THE ADVISORY COUNCIL of the Building Industry, which was inaugurated as a result of a deputation to the Minister of Health, consisting of Members of Parliament, architects, engineers, builders and building owners, in July of last year, held a meeting on May 29 for the purpose of adopting a constitution and the appointment of an Executive Committee to replace the temporary Organising Committee. The first meeting of the Executive Committee was held at the Royal Institute of British Architects recently, and considered in detail the suggestions to be forwarded to the London County Council for the revision of Parts V and VI of the London Building Act. The British Steelwork Association is represented on the executive committee by Mr. C. J. Kavanagh.

THE ENTRANCE EXAMINATIONS for the award of British Empire Scholarships in the Faculty of Engineering, Loughborough College, have now been completed and awards made. The scholarships are tenable at Loughborough for the full period of the Diploma Course, and the governors of the College have approved the following awards for 1931-32 :— (1) G. R. J. Wain-Heapy, St. Joseph's College, Naini Tal; (2) F. Dossor, Hymer's College, Hull; (3) H. J. Jenkins, Wellingborough School; (4) R. J. Gaul, Plumtree School, Southern Rhodesia; (5) S. Favel, Royal Commercial Travellers' Schools, Hatch End, and M. I. F. Green, Giggleswick School, Settle. These scholarships are open to British subjects resident in any part of the Empire, and are of the value of £75 per annum.

AN OFFER has been made by Templeborough Rolling Mills, Limited, to purchase the whole of the preference and ordinary shares of £1 each, fully paid, of Messrs. William Cooke & Company, Limited, of Sheffield, at 10s. 3d. for each preference and 6s. 3d. for each ordinary share, payable in cash. The directors of Messrs. William Cooke & Company state that, while the assets should be worth more than the offer, yet, having regard to the position of the company and the trade outlook, they recommend acceptance, and state that they have agreed to sell their own shares at the prices offered. The Templeborough Rolling Mills propose to pay £3,000 as compensation for loss of office to the retiring directors of Messrs. William Cooke & Company. The capital of Messrs. William Cooke & Company amounts to £250,000.

Personal.

COMMANDER C. W. CRAVEN, of Messrs. Vickers-Armstrongs, Limited, is at present on a business visit to Canada.

DR. G. L. KELLEY has joined the management of the Pressed Steel Company of Great Britain, Limited. He will be in charge of the manufacturing and engineering activities, and will supervise experiments and research work.

MR. PHILIP B. JOHNSON has been appointed general manager in charge of the St. Peters Works, Newcastle-upon-Tyne, of Messrs. R. & W. Hawthorn, Leslie & Company, Limited. Mr. Robert J. Allan, treasurer of the company, has been elected to a seat on the board.

MR. LAURENCE ENNIS, the former general manager of Messrs. Dorman, Long & Company, Limited, who has been in charge of the construction of the Sydney Harbour Bridge, has returned to England from Australia, where, with the exception of a few months' leave in this country, he has been working on the structure since 1924. Arrangements are being made for the official opening of the bridge at Easter next year.

MR. JAMES WILLIAMSON, foreman of the moulding department of Cruickshank & Company, Limited, Denny Iron Works, who is retiring after 45 years' service, was the guest of honour at a recent gathering of workers in the heavy moulding shop. Mr. John M'Laren, director, presided, and Provost Shanks, managing director, presented to Mr. Williamson an umbrella and a wallet of Treasury notes as parting gifts from his employers and the workers in general.

Wills.

PATTINSON, J. W., a director of the North Lonsdale Iron & Steel Company, Limited £11,421

GIBBINS, JOHN, of the Birmingham Battery & Metal Company, Limited, metal manufacturers £165,633

DOUGAL, LAWRENCE, of Bathgate, Scotland, formerly a director of the Bathgate Foundry Company, Limited ... £20,440

LUCAS, R. W., of Dronfield, Derby, a director of Messrs. Edward Lucas & Son, Limited, malleable-iron founders £12,409

Obituary.

MR. JOHN MARSHALL, head of Messrs. G. Marshall & Son, Limited, brassfounders and marine coppersmiths, North Quay, Monkwearmouth, died at his home in Sunderland on June 23. He was at one time managing director of the Yorkshire Copper Works, Limited.

SIR HUGH BELL, BART., chairman of Dorman, Long & Company, Limited, died in London on Monday, at the age of 87. He was the eldest son of Sir Lowthian Bell, and entered the family business of Bell Bros. in his eighteenth year. During his long career he made a large contribution to the development of Tees-side, and as chairman of the Tees Conservancy Commission assisted materially in improving the river. He was a Past-President of the Iron and Steel Institute and was awarded the Bessemer Gold Medal in 1926.

Contracts Open.

Simla, July 6.—Pumping plant, etc., for the India Stores Department. The Department of Overseas Trade. (Reference G.X. 10,497.)

Simla, India, July 30.—80 tons of ferro-manganese and 54,000 tons of tinned plates, for the Director of Contracts, Army Headquarters, India, Simla. The Director-General, India Stores Department, Belvedere Road, Lambeth, London, S.E.1. (Fee 5s., non-returnable.)

Springfield, near Cupar-Fife.—Switchgear, transformers, etc., for the Fife Joint Asylum Committee. Mr. A. H. Macdonald, interim clerk and treasurer, Fife Joint Asylum Committee, 12, St. Catherine Street, Cupar-Fyfe. (Fee £1 1s., returnable.)

Wallingford, July 9.—356 tons of spigot and socket cast-iron pipes and two tons of bends and branches, for the Rural District Council. Messrs. Fiddian & Deeley, engineers, 13, Church Street, Stourbridge.

Reports and Dividends.

Clayton & Shuttleworth, Limited.—Credit balance of £1,421, which is carried forward.

Platt Bros. & Company, Limited. — Net loss, £137,966; brought in, £4,544; debit balance carried forward, £133,422.

John Harper & Company, Limited.—Trading profit, £19,622; dividend of 7 per cent. on the ordinary shares; carried forward, £5,002.

John Hetherington & Sons, Limited.—Trading loss, £63,924; adverse balance brought in, £32,550; depreciation, £9,943; total debit, £106,417.

Edgar Allen & Company, Limited.—Net loss, £34,775; brought in, £7,678; from general reserve, £10,000; preference dividends, £15,000; debit balance carried forward, £32,097.

Greenwood & Batley, Limited.—Profit, £17,320; brought in, £13,801; transfer from provision for contingencies, £8,500; final dividend of 2½ per cent., making 5 per cent. for the year; carried forward, £9,174.

General Electric Company, Limited.—The full accounts show:—Profit, £1,122,007; brought in, £379,165; debenture interest, £209,444; depreciation, £241,676; pensions, £34,310; to reserve, £132,923; preference dividends, £252,000; ordinary dividend of 10 per cent.; carried forward, £400,880.

John Brown & Company, Limited. — Accounts show a balance, after charging debenture and loan interest and depreciation of plant and machinery at Clydebank and at collieries, of £10,532. The directors regret that the results do not permit of the payment of any dividends to preference or ordinary shareholders.

Baker, Perkins, Limited.—Net profit, after charging depreciation, etc., and providing £4,793 for income-tax, £55,360; brought in, £55,267; £25,000 set aside in 1929 as a reserve for 1930 revenue is also brought in; Dominion income-tax relief, £1,121; released from long credits reserve, £13,944; final dividend of 4 per cent. on the ordinary shares, making 7 per cent. for the year; to general reserve, £10,000; pension fund, £2,500; carried forward, £74,322.

Thos. Firth & Sons, Limited.—The report to December 31 last includes the accounts before the merger with John Brown & Company, Limited. Trading profit, after adjusting stock values, £48,181; net profit, after deducting debenture interest, etc., £25,902; reserve for contingencies arising in Australia and elsewhere, £15,000. The interim preference dividend absorbed £27,000 and the balance brought forward is consequently reduced from £119,081 to £102,982, no further payments being mentioned.

A Visit to Castlecary Firebrick and Silica Works.

(*Concluded from page* 13.)

kiln, which was used for burning "Thistle" bricks. The economy of the firing was clearly demonstrated, the heat from a fired chamber being used to preheat the air for combustion in unfired ones, so that the heat efficiency must be extremely high. A chamber is filled with bricks, and two weeks elapse from the charging of a green brick to its withdrawal from the kiln as the finished article. Examination of the bricks in kilns which were being drawn showed that the quality was uniformly high; there would be no trouble in the bedding of the bricks, the grain was good, and they were uniformly and well burnt.

From the stock room the visitors were taken to the silica section of the works, where "Bluebell" bricks were being made. The same high standard of plant planning was again evident, and in the final product the same high standard was attained. An interesting sideline was in a bay where the surfaces of large blocks were being ground by carborundum wheels to ensure perfect joints. The products arousing great interest were a display of "Stein" brand cupola bricks and shapes, together with "Stein 63" and "Stein 73" brands of high-alumina bricks used in the construction of enamelling muffles, etc. The last department to be visited was the work's canteen, where all enjoyed the hospitality of their hosts. Altogether this was a highly profitable and pleasant excursion.

XUM

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The Cleveland pig-iron market remains uninfluenced by the undercurrent of optimism which is now evident in many markets. Conditions here are considered to be fundamentally unsatisfactory. The area of distribution of Cleveland iron has rarely been so limited. The export trade is almost stationary and sales to Scotland are increasingly difficult to secure even at preferential prices. In the neighbourhood of producers' own works imported iron is being extensively used. Makers seem determined to maintain the prices which have governed the market for six months past, but trade is being lost in consequence. During the past two or three months Tees imports of iron have averaged about 1,000 tons per week, and larger lots are now reported to be on the way. However, except in Scotland the ironmasters will neither make price concessions themselves nor permit merchants to do so, and prices of Cleveland pig-iron are unchanged as follow:—No. 1 foundry, 61s.; No. 3 G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s. per ton.

Conditions are little better in the hematite market, where makers can only dispose of their output by continued price-cutting. However, there seems to be a growing belief that the market must be nearly touching bottom. Prices are so very irregular that only approximate values can be indicated. But for reasonable quantities makers have been readily accepting 62s. 6d. for mixed numbers, and still lower figures would be accepted for bigger tonnages. The fact that 3d. to 6d. per ton premium is asked for forward contracts indicates the prevailing opinion of the trend of prices, but there are large stocks on hand, and until these are dispersed they must be a source of weakness. The nominal price of Bessemer mixed numbers on the North-West Coast is still 66s.

LANCASHIRE.—The market has not developed in any way during the course of the past week. There has been no change in prices. The light-castings industry is reported to be far from active, and the quantity of foundry iron taken by the textile-machinery concerns is very small compared with a period of normal activity. For delivery to consumers in the Manchester zone, Derbyshire and Staffordshire descriptions of No. 3 are quoted at 67s. per ton, with North-East Coast iron also at 67s. The price of Northamptonshire foundry is 65s. 6d. and Derbyshire forge 62s. Scottish foundry brands are a little cheaper at about 87s. 6d., with West Coast hematite iron at 80s. 6d.

MIDLANDS.—The market is in a poor condition. Consumers are not prepared to book ahead, as they themselves continue to be short of work, with little hope of expansion till later on in the year. For delivery to Birmingham and Black Country stations the furnaces still quote 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, North Staffordshire and Lincolnshire No. 3.

SCOTLAND.—There is a general lack of activity in this market. Scottish pig-iron makers are quoting as a fixed minimum price 71s. per ton for No. 3 foundry, f.o.t. furnaces, with a minimum of 2s. 6d. per ton extra for No. 1. The price of Continental No. 3 is 52s., f.o.t. Grangemouth. Middlesbrough No. 3 is at 59s., or possibly less.

Finished Iron.

As in the case of other markets, finished iron is in a very poor position, even the mills making the best bars being unable to maintain anything like regular operations. Supplies of marked bars are quoted at £12 at works, and crown bars are at anything from £9 5s. to £10, a really good crown bar being obtainable at £9 15s. Little or no support is being given to the ironworks for nut and bolt iron at their prices of £8 10s. to £8 12s. 6d., the bulk of this business being placed abroad at low prices. Belgian No. 3 is quoted at between £4 12s. 6d. and £4 15s. delivered Black Country works.

Steel.

In the finished steel trade, consumers are expecting a revision of prices when the steel-makers meet this month, and there is in consequence a tendency to hold back any available orders of any substance, few as these may be. Business in small steel bars remains restricted, with keen competition amongst the makers and re-rollers. There is a firmer tendency in prices of Continental semi-finished steel, many of the makers having withdrawn quotations. This tendency may be attributed almost entirely to the better atmosphere created by the suggestion of a moratorium for war debts, and is not due to any substantial increase in the volume of business placed. Very few orders are being given to either the home or Continental works.

Scrap.

The amount of business done in the Cleveland iron and steel scrap market is still very limited. Ordinary-quality cast-iron scrap is now down to 42s. 6d., with good machinery quality at 44s. No improvement can be noticed in the position of the scrap market in the Midlands area. The greatest difficulty is found in booking new business, even in small quantities, and an even greater difficulty is found in getting delivery instructions against contracts booked weeks ago. Good heavy machinery cast-iron scrap in cupola sizes is offered at 47s. 6d., with light cast iron at 37s. 6d. The Scottish market is extremely quiet. First-class machinery metal, in pieces not exceeding 1 cwt., is quoted at 47s. 6d. to 48s. 6d., while ordinary cast-iron scrap to the same specification is at 42s. 6d. to 43s. 6d. The above prices are all delivered consumers' works.

Metals.

Copper.—The market is still benefiting from the change in sentiment produced by the Hoover proposals. The outlook, however, is not yet assured, for, pending an increase in the actual rate of consumption, the market can hardly be expected to retain its present tone.

Closing quotations:—

Cash.—Thursday, £38 18s. 9d. to £39 1s. 3d.; Friday, £38 2s. 6d. to £38 3s. 9d.; Monday, £40 7s. 6d. to £40 10s.; Tuesday, £38 10s. to £38 12s. 6d.; Wednesday, £36 to £36 2s. 6d.

Three Months.—Thursday, £39 12s. 6d. to £39 13s. 9d.; Friday, £38 15s. to £38 17s. 6d.; Monday, £41 to £41 2s. 6d.; Tuesday, £39 to £39 2s. 6d.; Wednesday, £36 12s. 6d. to £36 15s.

Tin.—The present international situation has given this market a more hopeful outlook. As in the case of other markets, the abnormally low figure for tin in recent weeks was due largely to the general lack of confidence. It is hoped that the world's consumption may have reached its lowest level, and, assuming that the effect of the quota scheme on the supplies of metal available will soon become more apparent, the statistical position may begin to improve, and the June figures may be better than was expected. As to current consumption, buying is moderate, but there is a good deal of hesitation, and the tinplate trade has yet to experience a real improvement.

Official closing prices:—

Cash.—Thursday, £111 7s. 6d. to £111 10s.; Friday, £112 10s. to £112 12s. 6d.; Monday, £118 5s. to £118 10s.; Tuesday, £114 2s. 6d. to £114 5s.; Wednesday, £113 2s. 6d. to £113 5s.

Three Months.—Thursday, £113 2s. 6d. to £113 7s. 6d.; Friday, £114 2s. 6d. to £114 5s.; Monday, £120 2s. 6d. to £120 5s.; Tuesday, £116 to £116 2s. 6d.; Wednesday, £115 2s. 6d. to £115 5s.

Spelter.—An improved demand from consumers has been experienced. This is probably due to the upward trend in prices, rather than to an actual increase in consumption, but it is expected that an expansion will follow.

Daily fluctuations:—

Ordinary.—Thursday, £13; Friday, £12 17s. 6d.; Monday, £13 12s. 6d.; Tuesday, £13 8s. 9d.; Wednesday, £12 11s. 3d.

Lead.—The market is now in a fairly satisfactory position. As in the case of other non-ferrous metals, the sentiment of the market is vastly improved, but it remains to be seen whether the ultimate consumption will maintain the demand on a sufficient scale to consolidate prices at the higher levels now attained.

The week's prices have been:—

Soft Foreign (Prompt).—Thursday, £13 2s. 6d.; Friday, £12 18s. 9d.; Monday, £13 11s. 3d.; Tuesday, £13 8s. 9d.; Wednesday, £13.

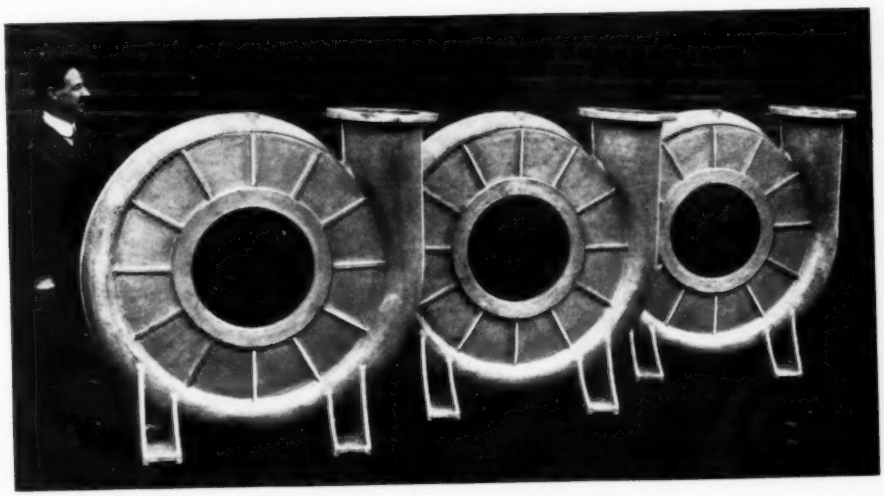
Company Meeting.

Armstrong Whitworth Securities Company, Limited.—The annual meeting of the Armstrong Whitworth Securities Company, Limited, was held in London on June 18. MAJOR-GENERAL G. P. DAWNAY (chairman of the company), who presided, said: I think we are entitled to consider the results for the year 1930 very satisfactory. On the assets side of the balance-sheet, the items of work in progress, sundry debtors (less creditors), investments and cash and loans at short notice have been reduced since the previous year by just over £1,000,000. On the other hand, the various items under shares in and amounts owing from subsidiary companies have been increased by just over £1,000,000. These increases and decreases practically balance, and indicate that the reduction in work in progress, in net debtors and in investments and cash are reflected in increased loans to the shipbuilders and engineers' companies in respect of credit shipbuilding operations; they also reflect certain capital expenditures on new developments and an additional investment in the first mortgage debentures of the Partington Steel & Iron Company, of which we now own practically the whole amount outstanding, made in order to facilitate the reconstruction of the Pearson & Knowles group of companies, in which we are considerably interested. As regards trade investments, our holding in Vickers-Armstrongs stands at the same figure as previously, while our investment in other companies has been increased by about £250,000. As regards the three main operating companies, the Engineers Company showed a profit for the year, after making adequate provision for depreciation, contrasting favourably with the loss shown by that company in the previous accounts. The Shipbuilding Company also showed a profit for the year, after adequate depreciation, against a considerable loss in the preceding year. This was due to shipbuilding contracts taken on credit terms. The Ironfounders Company has also been able to show a profit.

CAST IRON FLANGED PIPES
2 in.–12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone: 3852 (2 Lines). MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

F.T.J. 2.7.31

to cast these



These aluminium housings for electrical boosting and exhausting fans were cast by William Mills, Ltd. The impellers are also of aluminium alloy. (By courtesy of James Keith & Blackman Co., Ltd.)

Have you had the latest B.A.C. Aluminium Foundry Data? (issued gratis and without obligation).

the choice was Aluminium

THE BRITISH ALUMINIUM CO., LTD., ADELAIDE HOUSE, KING WILLIAM STREET, LONDON, E.C.4.

Telephone: Mansion House 5561. & 8074 (5 lines). Telegrams: Cryolite, Bilgate, London

Special CARBON BLACKING

67 YEARS EXPERIENCE. MADE BY A FIRM WITH

JAS. DURRANS & SONS. LIMITED.

PHŒNIX WORKS PENISTONE. NR. SHEFFIELD.

Also—

GANISTER, LOAM AND SAND MILLS.

STUDS, CHAPLETS, BRUSHES, CORE ROPES, BUCKETS, SPADES, Etc. LADLES, FIRE BRICKS, STONE FLUX, CASTING CLEANERS, PIPE NAILS, SPRIGS, WIRE BRUSHES, BELLOWS.

PLUMBAGO

CORE GUM

WHITE DUST

COAL DUST

REQUISITES

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	36	0	0
Three months	36	12	6
Electrolytic	40	10	0
Tough	39	0	0
Best selected	39	10	0
Sheets	70	0	0
India	52	10	0
Wire bars	42	17	6
Do., August	42	17	6
Do., September	42	17	6
Ingot bars	42	17	6
H.C. wire rods	44	10	0
Off. av. cash, June	35	17	6 5/14
Do., 3 mths., June	36	10	10 11/14
Do., Sttlmnt., June	35	17	4 7/11
Do., Electro, June	39	7	10 1/11
Do., B.S., June	37	10	10
Do., wire bars, June	39	16	4 1/11
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			6¾d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8½d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7⅞d.
Wire	7½d.
Rolled metal	7d.
Yellow metal rods	5d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN.

	£	s.	d.
Standard cash	113	2	6
Three months	115	2	6
English	115	10	0
Bars	117	5	0
Straits	115	12	6
Australian	115	2	6
Eastern	116	17	6
Banca	117	7	6
Off. av. cash, June	105	0	8 5/11
Do., 3 mths., June	106	13	5 13/19
Do., Sttlmt., June	105	1	1 7/11

SPELTER.

	£	s.	d.
Ordinary	12	11	3
Remelted	11	15	0
Hard	9	10	0
Electro 99.9	15	12	6
English	13	17	6
India	11	5	0
Zinc dust	20	0	0
Zinc ashes	2	15	0
Off. aver., June	11	10	2 17/20
Aver. spot, June	11	5	4 17/23

LEAD.

	£	s.	d.
Soft foreign ppt.	13	0	0
English	14	10	0
Off. average, June	11	15	4 1/11
Average spot, June	11	11	7 17/23

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	20	0	0
Do., V.M. ex-whf.	19	5	0
Rods	22	0	0
Boiler plates	14	5	0
Battery plates	16	5	0

ANTIMONY.

	£	s.	d.
Special brand, Eng.	34	0	0
Chinese	23	2	6
Crude	19	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	16	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 7 6
45/50%	£10 7 6
75%	£15 2 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9½d. lb.
Ferro-phosphorus, 20/25%	£15 10 0
Ferro-tungsten—	
80/85%	1/8½ lb.
Tungsten metal powder—	
98/99%	1/11½ lb.
Ferro-chrome—	
2/4% car.	£28 15 0
4/6% car.	£21 5 0
6/8% car.	£20 16 0
8/10% car.	£19 15 0
Ferro-chrome—	
Max. 2% car.	£29 10 0
Max. 1% car.	£32 17 6
Max. 0·70% car.	£35 12 6
70% carbon-free	9½d. lb.
Nickel—99% £170 0 0 to £175 0 0	
Ferro-cobalt	8/9 lb.
Aluminium 98/99%	£85 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose £10 15 0 to £11 5 0	
76/80% packed £11 15 0 to £12 5 0	
76/80% export (nom.) £9 0 0	
Metallic manganese—	
94/96% carbonless	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales						
Heavy steel				2	0	0
Bundled steel and shrngs.	1	14	0 to	1	18	6
Mixed iron and steel				1	17	6
Heavy cast iron				2	5	0
Good machinery for foundries				2	7	6
Cleveland—						
Heavy steel				1	17	6
Steel turnings				1	5	0
Cast-iron borings				1	2	0
Heavy forge				2	13	0
W.I. piling scrap				2	10	0
Cast-iron scrap	2	2	6 to	2	4	0
Midlands—						
Light cast-iron scrap				1	17	6
Heavy wrought				2	7	6
Steel turnings					—	
Scotland—						
Heavy steel				1	17	6
Ordinary cast iron				2	0	0
Engineers' turnings				1	5	0
Cast-iron borings				1	10	0
Wrought-iron piling				2	7	6
Heavy machinery				2	8	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	30	0	0
Brass	21	0	0
Lead (less usual draft)	10	10	0
Tea lead	7	10	0
Zinc	6	0	0
New aluminium cuttings	52	0	0
Braziery copper	27	0	0
Gunmetal	26	0	0
Hollow pewter	75	0	0
Shaped black pewter	56	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/–
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/–
Hematite No. 1	63/–
Hematite M/Nos.	62/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	73/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/–
Midlands—	
Staffs common*	—
,, No. 4 forge*	61/–
,, No. 3 fdry.*	66/–
Shrops basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	57/6
,, fdry. No. 3*	62/6
,, fdry. No. 1*	65/6
Derbyshire forge*	61/–
,, fdry. No. 3*	66/–
,, fdry. No. 1*	69/–
,, basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	73/6
,, No. 3	71/–
Hem. M/Nos. d/d	70/–
Sheffield (d/d district)—	
Derby forge	58/6
,, fdry. No. 3	63/6
Lincs forge	—
,, fdry. No. 3	63/6
E.C. hematite	78/6
W.C. hematite	82/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/–
,, fdry. No. 3	67/–
Staffs fdry. No. 3	67/–
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/–
Dalzell, No. 3 (special)	102/6 to 105/–
Glengarnock, No. 3	87/6
Clyde, No. 3	87/6
Monkland, No. 3	87/6
Summerlee, No. 3	87/6
Eglinton, No. 3	87/6
Gartsherrie, No. 3	87/6
Shotts, No. 3	87/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	15	0 to	10	10	0
Nut and bolt iron	8	10	0 to	8	12	6
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				12	5	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	17	6 to	9	12	6
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)			6 12 6 & up.			
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)				9	5	0
Black sheets, 24g.	8	5	0 to	9	5	0
Galv.cor.shts.24g.	9	15	0 to	10	0	0
Galv. flat sheets	10	5	0 to	10	10	0
Galv. fencing wire, 8g. plain				12	0	0
Billets, soft				5	0	0
Billets, hard				6	12	6
Sheet bars	4	12	6 to	5	0	0
Tin bars				4	12	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	11½d.
Rods	11½d.
Tubes	1/4½d.
Castings	11½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
5% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
3/– to 10 g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry. Phila.	17.26
No. 2 foundry, Valley	17.00
No. 2 foundry, Birm.	12.00
Basic	17.26
Bessemer	18.76
Malleable	18.76
Grey forge	18.26
Ferro-mang. 80%	85.00
O.-h. rails, h'y, at mill	43.00
Billets	29.00
Sheet bars	29.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.65
Tank plates	1.65
Beams, etc.	1.65
Skelp, grooved steel	1.65
Skelp, sheared steel	1.65
Steel hoops	1.85
Sheets, black, No. 24	2.15
Sheets, galv., No. 24	2.75
Sheets, blue an'l'd, No. 13	2.00
Wire nails	1.80
Plain wire	2.20
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	20/– to 22/6
,, furnace	15/–
Durham and Northumberland—	
,, foundry	13/–
,, furnace	13/–
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	13/9 to 14/–
,,	28×20 ,,	27/6
,,	20×10 ,,	20/–
,,	18¾×14 ,,	14/6
C.W.	20×14 ,,	13/–
,,	28×20 ,,	27/–
,,	20×10 ,,	19/7½
,,	18¾×14 ,,	14/6
Terneplates	28×20	27/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 to £18 10 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars and rods dead soft, st'l	£11 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Current Discounts.

	Tubes.	*Fittings.*
Gas	62½%	57½%
Water ..	58½%	52½%
Steam ..	55%	47½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
June	25 ..	38	18	9	inc.	26/3
,,	26 ..	38	2	6	dec.	16/3
,,	29 ..	40	7	6	inc.	45/–
,,	30 ..	38	10	0	dec.	37/6
July	1 ..	36	0	0	,,	50/–

Electrolytic Copper.

		£	s.	d.		
June	25 ..	41	10	0	inc.	20/–
,,	26 ..	41	0	0	dec.	10/–
,,	29 ..	42	10	0	inc.	30/–
,,	30 ..	41	10	0	dec.	20/–
July	1 ..	40	10	0	inc.	20/–

Standard Tin (cash).

		£	s.	d.		
June	25 ..	111	7	6	inc.	70/–
,,	26 ..	112	10	0	,,	22/6
,,	29 ..	118	5	0	,,	115/–
,,	30 ..	114	2	6	dec.	82/6
July	1 ..	113	2	6	,,	20/–

Tin (English ingots).

		£	s.	d.		
June	25 ..	112	10	0	inc.	70/–
,,	26 ..	113	10	0	,,	20/–
,,	29 ..	119	10	0	,,	120/–
,,	30 ..	115	5	0	dec.	85/–
July	1 ..	115	10	0	inc.	5/–

Zinc Sheets (English).

		£	s.	d.		
June	25 ..	20	0	0	No	change
,,	26 ..	20	0	0	,,	,,
,,	29 ..	20	0	0	,,	,,
,,	30 ..	20	0	0	,,	,,
July	1 ..	20	0	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
June	25 ..	13	0	0	inc.	3/9
,,	26 ..	12	17	6	dec.	2/6
,,	29 ..	13	12	6	inc.	15/–
,,	30 ..	13	8	9	dec.	3/9
July	1 ..	12	11	3	,,	17/6

Lead (English).

		£	s.	d.		
June	25 ..	15	0	0	inc.	10/–
,,	26 ..	14	10	0	dec.	10/–
,,	29 ..	15	0	0	inc.	10/–
,,	30 ..	15	0	0	No change	
July	1 ..	14	10	0	dec.	10/–

AVERAGE MONTHLY PRICES OF RUBIO ORE (MIDDLESBROUGH).

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1890	0 15 4	0 15 4	0 15 4	0 15 4	0 15 4	0 15 4	0 15 4	0 14 3	0 14 3	0 15 7½	0 15 7½	0 15 7½	0 15 2½
1891	0 15 7½	0 14 2½	0 14 2½	0 14 2½	0 13 6½	0 13 6	0 13 3½	0 13 0	0 12 11	0 13 0	0 13 7	0 13 1	0 14 9½
1892	0 13 1	0 12 9	0 12 9	0 12 9	0 12 9	0 11 10½	0 12 1	0 12 1	0 12 2	0 12 0	0 12 0	0 11 11	0 12 4½
1893	0 11 11	0 11 5½	0 11 10	0 11 10	0 12 1½	0 12 3	0 12 1½	0 12 3	0 12 1	0 12 4	0 12 4½	0 12 6	0 12 0½
1894	0 12 6	0 12 6	0 12 7½	0 12 1½	0 12 4	0 12 1	0 12 0	0 12 0½	0 11 10½	0 12 2	0 12 0	0 12 0	0 12 1½
1895	0 12 0	0 12 0	0 11 10	0 12 0	0 12 0	0 12 3	0 12 3	0 12 4	0 12 4	0 12 6	0 12 7	0 12 6	0 12 2½
1896	0 12 6	0 12 6	0 12 9	0 12 9	0 12 9	0 12 7	0 12 9	0 12 9	0 12 9	0 13 6	0 15 0	0 14 9	0 13 1
1897	0 15 3	0 15 6	0 15 3	0 15 0	0 14 0	0 14 3	0 14 3	0 14 0	0 14 0	0 15 0	0 14 3	0 15 3	0 14 8
1898	0 15 0	0 14 4	0 14 9	0 14 6	0 15 0	0 15 0	0 14 0	0 14 0	0 14 0	0 14 9	0 15 0	0 14 9	0 14 7
1899	0 15 0	0 15 3	0 15 6	0 15 6	0 15 9	0 16 0	0 17 6	0 18 0	0 17 9	0 18 0	0 19 0	1 0 0	0 16 11½
1900	1 1 0	1 0 6	1 1 0	1 0 9	1 1 0	1 1 0	1 1 3	1 1 6	1 1 3	1 1 3	1 0 0	0 18 0	1 0 8½
1901	0 17 6	0 16 0	0 15 0	0 14 6	0 15 6	0 15 9	0 14 9	0 15 3	0 15 9	0 15 9	0 15 9	0 15 9	0 15 7½
1902	0 15 6	0 15 0	0 16 0	0 16 0	0 15 6	0 15 3	0 15 6	0 16 0	0 16 0	0 16 0	0 15 9	0 15 6	0 15 8½
1903	0 15 6	0 16 0	0 16 6	0 16 3	0 16 3	0 16 10	0 15 9	0 15 6	0 15 6	0 14 9	0 14 9	0 15 1	0 15 8
1904	0 14 9	0 15 3	0 15 1	0 15 4	0 15 3	0 15 0	0 14 5	0 14 6	0 14 6	0 14 6	0 14 6	0 14 7	0 14 9½
1905	0 15 3	0 15 6	0 15 0	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 16 6	0 18 6	0 18 9	0 18 9	0 16 3½
1906	1 0 0	1 1 6	1 0 0	1 0 0	0 19 6	1 0 0	0 19 6	0 19 4	1 0 6	1 1 6	1 1 9	1 3 6	1 0 7
1907	1 3 6	1 2 6	1 2 6	1 2 0	1 1 6	1 2 3	1 2 3	1 2 0	1 1 0	0 19 0	0 18 9	0 17 6	1 1 2½
1908	0 16 6	0 15 0	0 15 6	0 15 6	0 15 3	0 15 0	0 15 0	0 14 9	0 15 0	0 16 0	0 16 0	0 16 0	0 15 5½
1909	0 15 9	0 16 3	0 16 0	0 16 0	0 16 3	0 16 6	0 16 0	0 16 0	0 17 0	0 17 0	0 17 6	0 17 6	0 16 6
1910	1 0 4	1 0 9	1 0 9	1 0 9	1 0 9	1 0 9	1 0 9	1 0 3	1 0 3	1 0 6½	1 1 3	1 1 5	1 0 9½
1911	1 2 2½	1 2 6	1 2 6	1 1 11½	1 0 11½	0 19 6	0 19 0	0 19 0	0 19 1½	0 19 6	1 0 0½	1 1 6½	1 0 7½
1912	1 2 3	1 2 6	1 2 6	1 1 1½	1 1 6	1 1 6	1 1 6	1 2 3	1 2 6	1 3 0	1 3 0	1 2 11	1 2 2½
1913	1 2 9	1 2 2	1 1 7½	1 1 6	1 0 8½	1 0 0	1 0 0	1 0 0	0 19 10½	0 19 1½	0 19 0	0 19 0	1 0 5½
1914	0 18 7½	0 18 0	0 18 0	0 17 9	0 17 6	0 17 6	0 17 1½	0 19 7½	0 18 11½	0 17 10½	0 18 7½	1 1 0½	0 18 5½
1915	1 7 7½	1 8 6	1 9 3	1 10 2½	1 8 6	1 6 4	1 5 10½	1 6 0	1 6 10½	1 10 8½	1 13 0	1 17 10	1 9 1½
1916	1 18 6	2 0 1½	2 2 6½	2 0 6½	1 15 0	1 16 3	1 18 0	1 18 0	1 18 0	—	—	—	—
1917	Price Fixed												
1918													
1919	—	—	—	—	2 5 7½	2 14 4½	2 16 4½	2 14 0	2 13 4½	2 13 0	2 12 7½	2 11 9	—
1920	2 17 0	3 7 9	2 15 6	3 6 7	3 0 0	2 15 0	2 14 0	2 9 9	2 7 6	2 11 0	2 12 3	2 10 0	2 15 0
1921	2 1 0	2 0 1½	1 18 3	1 17 6	1 17 6	1 17 6	1 17 6	1 5 0	1 8 9½	1 7 9	1 7 0	1 7 0	1 13 8½
1922	1 6 7½	1 5 10½	1 6 11	1 7 0	1 7 0	1 7 0	1 5 3	1 4 9½	1 4 2½	1 3 3½	1 2 6	1 2 3	1 5 2½
1923	1 2 9½	1 4 6½	1 5 2	1 4 8½	1 4 6	1 4 0	1 3 6	1 3 0	1 3 0	1 3 0	1 3 2½	1 4 9	1 3 10½
1924	1 4 2½	1 4 0	1 4 0	1 3 7½	1 3 8½	1 3 6	1 2 11	1 2 6	1 2 1½	1 1 7½	1 2 3	1 2 6	1 3 1
1925	1 2 6	1 2 1½	1 2 0	1 2 0	1 2 0	1 1 6	1 0 6	1 0 0	1 0 0	1 0 0	1 0 3	1 0 10½	1 1 1½
1926	1 1 1½	1 1 6	1 1 6	1 1 3½	1 1 3	1 1 5½	1 1 6	1 1 6*	1 1 0*	1 1 6*	1 1 6*	*	1 1 4½
1927	1 2 1½	1 2 3	1 2 1½	1 2 0	1 2 0	1 2 0	1 1 7½	1 1 0	1 1 0	1 1 0	1 1 0	1 1 0	1 1 7½
1928	1 1 0	1 1 1½	1 1 11	1 2 4½	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 2½
1929	1 2 6	1 2 6½	1 2 11½	1 3 0	1 3 0	1 3 2½	1 4 0	1 4 8½	1 4 7½	1 4 6	1 4 6	1 4 3	1 3 7½
1930	1 3 3½	1 2 6	1 1 9	1 1 6	1 0 10½	1 0 0	1 0 0	0 19 6	0 19 0	0 17 4½	0 16 4½	0 16 4½	0 19 10½
1931	0 16 1½	0 16 0	0 16 0	0 15 11½	0 15 4½	0 15 0½	—	—	—	—	—	—	—

* Prices nominal.

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